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THE JOURNAL OF PERIODONTOLOGY is published to serve as the professional journal of periodontia; to keep dentists in touch with research being carried on in this field and related sciences; to stimulate greater interest in the supporting tissues of the teeth and their relation to oral and general health.

The Journal is the official organ of the American Academy of Periodontology and will contain, therefore, papers of scientific and clinical interest which are presented at the annual meetings of that society, as well as articles submitted direct to the Editor. Obviously opinions expressed do not necessarily represent those of the Editor or the American Academy of Periodontology.

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THE AMERICAN ACADEMY OF PERIODONTOLOGY

September 27, 28, 29, 1956

Atlantic City, N. J.

1956 Spring Conference

of

THE AMERICAN ACADEMY OF PERIODONTOLOGY

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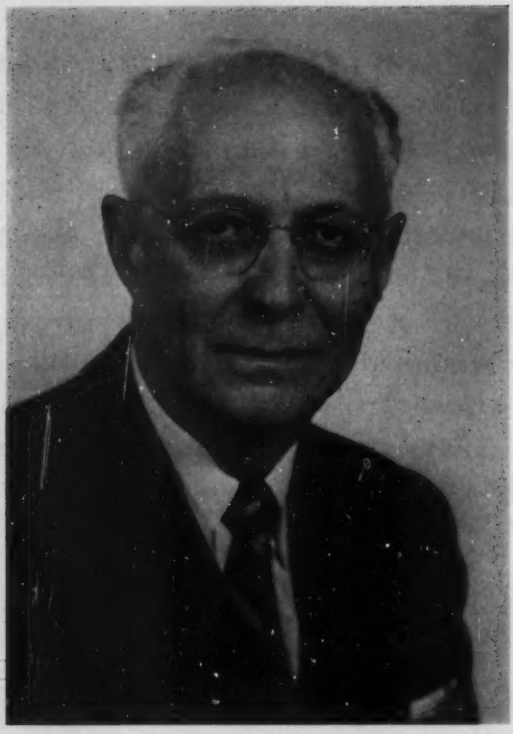

M. MONTE BETTMAN, D.M.D.

Portland, Oregon

One of the most active periodontists on the West Coast is Dr. M. Monte Bettman of Portland, Oregon. Dr. Bettman has been an active member of the American Academy of Periodontology since 1919 and was president of that organization in 1934. He is a diplomate of the American Board of Periodontology and was a member of the Examining Board from 1939 to 1954.

Dr. Bettman has been most active in organized dentistry and has given many papers and clinics on the subject of periodontology. He is reputed to be the first dentist in the Pacific Northwest to specialize in the treatment of periodontal diseases. In addition to his busy professional life, Dr. Bettman finds time to be active in community affairs.

THE JOURNAL OF PERIODONTOLOGY

APRIL, NINETEEN HUNDRED FIFTY-SIX

Bacterial Flora of the Mouth*

by VALERIE HURST, PH.D.,** *San Francisco, California*

IN most problems of medical science today the urgency for collaboration between the clinician and the biologist is becoming apparent. This seems to be true particularly in periodontology. Bacteriological knowledge has expanded greatly in recent years, and new technics have been developed, many of which might profitably be applied toward solving the complexities of periodontal disease.

There has been a prevailing view in recent years that bacteria play no more than a secondary, or indirect, role in periodontal disease. While this may be true, it must not be used as an excuse to dismiss bacteria from our consideration entirely. Most periodontists will agree that if bacteria were not present in the periodontal pocket, the clinical disease picture might be entirely different, and the clinical course of much shorter duration.

In elucidating the role of bacteria in periodontal disease, we are faced with one of the most difficult problems of medical science. This is because the gingival sulcus is an area where a large number of different kinds of bacteria may multiply simultaneously. In other words, we are dealing with a mixed infection. Our problem is to distinguish between those most actively participating in the disease process from those which may be there only incidentally.

One of the major obstacles here is that we are not yet certain which bacterial products are injurious to the gingival tissues. Some of them may be enzymes such as hyaluronidase and collaginase. These are bacterial enzymes known to be produced by a variety of bacteria which are distributed widely throughout nature. Some of the bacteria producing them are found in the periodontal pocket. These enzymes potentially are capable of digesting the ground substance and collaginase of the connective tissue. It is postulated that by so doing they contribute to gingival detachment and render the tissues more vulnerable to bacterial invasion. These enzymes are now a subject of considerable investigation for their clinical implications potentially are very great. We must remember, however, that there are certain paradoxes about these enzymes which remain unexplained: (1) The ability of a bacterium to produce hyaluronidase does not necessarily parallel its invasive power.[1,2] For example, some of the most virulent

*Presented at the forty-first meeting of the American Academy of Periodontology, San Francisco, California, October 14, 1955.

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strains of hemolytic streptococci produce only a little of it, whereas some of the least virulent streptococci produce it most abundantly. *Clostridium welchii,* which produces large amounts and causes gas gangrene, has been found to still cause gangrene even when hyaluronidase neutralizing substances are present. (2) While these enzymes have been shown to be formed in the periodontal pocket, their actual diffusion into the connective tissue has not yet been demonstrated. (3) We have no direct evidence that the enzymes formed in the periodontal pocket actually enhance bacterial invasion of the submucosa. That these last two processes do occur are reasonable suppositions. However, we must remember that these enzymes still may prove only coincidental to the periodontal process.

While further work on these bacterial enzymes is imperative, it would seem unwise to concentrate all our research efforts on them, for eventually they may prove not as important as they appear at the moment. There are other avenues of research also worth attention. As was mentioned earlier, the role of bacteria in periodontal disease is confused by the fact that so many different bacteria are found in the periodontal pocket. As yet, we have no method for distinguishing the harmless commensals from the pathogens, and this is partly because we know so little about the harmless bacteria present in the normal healthy mouth and gingival crevice. If we knew more about the kinds of bacteria present in the healthy mouth we might, simply by their exclusion, be in a better position to designate the pathogens associated with periodontal disease.

We know that the normal mouth contains a great many different kinds of bacteria in large numbers, and at first glance the task of sorting them out is almost overwhelming. Yet, as is often the case, the problem may not be so difficult if the right approach is selected. Theoretically, the oral flora is more complex in later life than in early infancy. A logical approach, therefore, may be to give first consideration to the bacteria present in a baby's mouth. At this time the situation is still uncomplicated by the presence of teeth, and the basic flora is just becoming established.

A baby's mouth is usually sterile at birth, but within the first twenty-four hours bacteria begin to appear. One might expect that a baby's mouth is a site where any and all bacteria could multiply, yet this is not the case. It is a curious and fascinating fact that the newborn baby's mouth is highly selective, permitting only certain kinds of bacteria to multiply. They are the bacteria which commonly are found in the mouths of healthy adults, i.e., viridans streptococci, staphylococci, diphtheroids, Neisseria, hemophili, Veionella, etc. Other bacteria, common to the air and soil, are quickly eliminated. This high degree of selectivity is an important principle to remember, because it applies also in later life. It means that in our examination of the normal mouth flora, we will not be confronted with every conceivable species of bacteria, but only with those which are particularly adapted to this habitat. It implies, also, that bacteria which cause oral disease likewise must be adapted to the oral environment, and secondly, that they must be able to live in harmony with the normal flora.

Examination of the baby's mouth bacteria reveals another fundamental and interesting principle. This is that those strains of bacteria which first become established just after birth tend to persist, and are not readily replaced by other strains even of the same species. There is evidence that this persistence of strains applies also in the adult mouth. "Strains" are subspecies of bacteria which sometimes may be identified by serological methods. Strains so identified are usually referred to as types. Serologic typing is a technic which dental research might usefully apply much more extensively than it has to date. In medical research on the upper respiratory infections, serologic typing has shown that certain serologic types of pneumococci and strepto-

Fig. 1. Filamentous organisms on the enamel surface. f—filamentous organisms; e—enamel; t—tear in section (artifact). 150X; hematoxylin and eosin stain. Courtesy of Harry E. Frisbie.

cocci may persist in the healthy adult mouth for very long periods. It has also been found that particular types are most likely to be associated with disease. For example, the pneumococci have been subdivided into about 75 serologic types, and of these types, 1 and 2 commonly cause pneumonia. Some of the other serologic types rarely cause pneumonia and are frequent components of the healthy oral flora. Hemolytic streptococci, similarly can be divided into a large number of serologic types, and very recently it has been observed that nephritis is a likely sequela in infections due to type 5. Potentially, serologic typing can yield much information about the oral flora, and might even help solve some of the complexities of periodontal disease.

Very recently still another method has become available, known as phage typing. Phages are viruses that are parasitic on bacteria. The phage typing method makes use of the fact that one subspecies, or type, of bacteria will be destroyed by one group of phages, while another subspecies will be destroyed by quite a different group of phages. Phage typing is particularly applicable to the staphylococci, and this method may prove of real value in future periodontal research. Staphylococci are common in the mouth, and they are also abundant producers of hyaluronidase. By applying staphylococcal phage typing in my own research on babies' mouths,[3] we have been able to demonstrate that the staphylococcal types which become established just after birth sometimes persist for at least a year and a half. Perhaps they may persist even longer; observations of some of these babies who are now a year and a half old are being continued.

Many newborn babies acquire several strains of staphylococci in their mouths and continue to carry these simultaneously. Because the strains acquired are determined largely by chance, a baby may have its own individual set of strains. In an analysis of the strains present in the noses and mouths of 50 babies, 70% of them could have been

identified by their staphylococci. This is a significant fact, because it proves that not all individuals share the same mouth flora. Contrary to expectation, a baby does not necessarily acquire the bacterial flora present in other family members with whom it is in contact. This became particularly apparent during observations on sets of identical twins. Despite their intimate association with one another, infant twins had different staphylococci, pneumococci, and coliforms present in their mouths. This individuality and permanency of a baby's oral flora may be of very fundamental importance, for it may determine the bacteria which can become established in the mouth in later life. This may even include some of the pathogens.

During studies on the flora of the infant mouth, the author has often been asked whether it is identical in composition to that of the adult. There is no complete answer yet. While one might expect that the flora would be affected by the appearance of teeth, I have not yet found evidence of this. In textbooks, it is often stated that fusiforms and spirochetes do not appear until tooth eruption, and the development of the gingival crevice. We have not yet examined the baby's mouth for spirochetes, but as for fusiforms, the textbook statement is falacious. Fusiforms have been cultivated in our laboratory from the mouths of many babies under two months old, and from nearly all babies before the eruption of their first incisors. It would indeed be interesting to know whether the fusiforms present in the mouths of babies are the same strains which are associated with periodontal disease. Answer to this awaits the development of methods enabling us to subdivide the fusiforms into types, just as we are now able to subdivide staphylococci, pneumococci, and streptococci. We may not have to wait long, for already some progress in subdividing fusiforms is being made. A few years ago, Jackins[4] was able to differentiate fusiforms isolated from the healthy adult mouth into two kinds having distinctly different metabolic characteristics. This work is now being extended further by Omata,[5] who is using paper chromatography to analyze the metabolic products of the fusiforms. Thus, in a few more years we should be in a much better position to distinguish the fusiforms of the healthy mouth from those present in periodontal disease.

This finding of fusiforms in the baby's mouth does not, of course, mean that there is no change in the oral flora when the teeth erupt. There are certain bacteria in the healthy adult mouth which seem to be associated with enamel surfaces. Unfortunately, they have been little studied, and have never been classified satisfactorily. Morphologically, they appear as long Gram positive filaments. In histologic sections they are seen abundantly in palisade arrangement on the enamel surface (Fig. 1). Some investigators have termed them leptothrix, others would classify them among the higher fungi, and in our laboratory we consider that at least some of them are actinomycetes. It is not known whether these microorganisms are present in the mouth before the teeth erupt, or whether they make their first appearance at this time. The obstacle here is that, in general, they seem to be a group of bacteria difficult to cultivate. It was heartening to learn at the recent I.A.D.R. meetings that Bibby and co-workers[6] are now investigating media which will be suitable for their cultivation. These organisms have also been suspected to play a role in calculus formation. Certainly they do comprise a large part of the calculus mass, as may be seen in histologic section. Looking at the large number of filamentous organisms in a calculus mass, it is difficult to believe that calculus contributes to periodontal inflammation only as a mechanical irritant. That these bacteria must play some important function was already emphasized this morning. However, as this group of organisms have been so little studied, nothing is yet known about the toxic substances which they may produce. It is not even known whether they

produce any of the enzymes held suspect in periodontal disease.[7] The need for further research here is obvious.

It is difficult to evaluate the role of specific bacteria in periodontal disease because it is a mixed infection in which, potentially, a variety of bacteria may participate. Our problem is to distinguish those in active participation from those which are incidental. Real progress in this is now being made by MacDonald and co-workers.[8,9] They have painstakingly isolated a variety of bacteria from the periodontal pocket, and have injected different combinations of these into the subcutaneous groin tissues of guinea pigs. In their report at the I.A.D.R. meetings last spring, they stated that they had produced inflammation with a mixture containing bacteria classified as Bacteriodes, a Gram negative rod, and a diphtheroid. They believe that the inflammation produced by this mixture is very similar to the inflammation which they obtain when they inject exudate taken directly from a periodontal pocket, without purification. Of course, it remains to be determined whether the inflammation which they produce in the guinea pig groin has a real relationship to periodontal inflammation. However, their work suggests that the fusiforms and spirochetes, which have so long been held suspect in periodontal disease, may have only a minor role. Their work also lends experimental support to the concept that periodontal disease results not from just one kind of bacteria, but from a number of bacteria acting in combination.

In conclusion, studies of bacteria in both the normal and diseased mouth, the interrelationships of these bacteria, and the substances they produce, are all necessary to an understanding of periodontal disease. If research is directed along all these lines, periodontal disease perhaps will not only become understood, but will be controllable.

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Repair of Gingival Defects by a Sliding Flap Operation

by HAROLD E. GRUPE, D.D.S.,* *Amarillo, Texas* AND RICHARD F. WARREN, JR., B.SC., D.D.S.,* *Houston, Texas*

DEFECTS of the labial gingiva in the area of the lower central incisors, often unilateral, sometimes bilateral, present a difficult problem. Many of these defects are associated with a high insertion of the lower labial frenulum. This state is supposedly the cause of the gingival recession, but possibly only an aggravating feature, and certainly prevents any healing of the defect.[1-2] Since the attached gingiva is absent, or greatly reduced at the bottom of the defective area, the alveolar mucosa is under mechanical irritation. Materia alba and calculus easily accumulate and chronic inflammation is a constant finding. Because routine treatment, including frenotomy, has not been successful, an attempt was made to correct the defect by a sliding flap operation. Some effort has been made previously to reposition the attached gingiva in the management of deep pockets extending beyond the mucogingival junction.[3] In these cases, however, no defect in the form of an isolated gingival recession existed.

OPERATIVE PROCEDURE

Infiltration anesthesia is employed, using a one inch, thirty gauge needle. The area of operation must be freed of all foreign material by judicious scaling, and planing of the affected root surface, obtaining a smooth, glossy cementum (or dentin).

Incisions are made on each side of the defect (Fig. 1, A&B), removing only the inflamed margin and extending straight downward to a level slightly below the base of the defect. These incisions are connected by a horizontal one at the base (Fig. 1, C). The tissue about the defect is removed, completely eliminating the epithelial lining of the soft tissue and the epithelial attachment. [At this time, a frenotomy may be performed if it is indicated. In such cases, the fibers of the frenulum are severed from the periosteum by sharp dissection and the overlying mucosa is separated from the lip by blunt dissection. This permits the lower edge of the lip mucosa to be sutured to the lowest point of the vestibule using a chromic gut (0000) on a half-round atraumatic needle (thus preventing the reattachment of the fibers of the frenulum to their original location).]

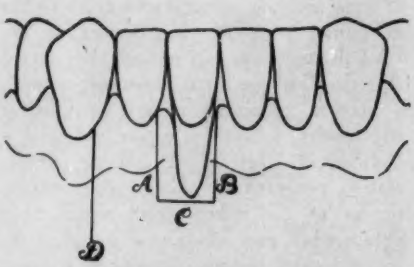

Fig. 1. Diagram illustrating incisions made in the sliding flap operation.

Another incision is made at the distance of one papilla distal to the defect (Fig. 1, D), being careful that it is not made through the crest of a papilla, in a direction straight downward into the alveolar mucosa as far as may be necessary to provide adequate mobility to the flap which has just been described. This flap should be made wide enough to easily cover the defect. In reflecting the flap the attached gingiva is separated from the underlying bone by blunt dissection down to its junction with the alveolar mucosa. At this point, by sharp dissection, the alveolar mucosa is separated from the underlying soft structures, so that

*Dental Corps, U. S. Army Hospital, Camp Chaffee, Arkansas.

the alveolar bone is not exposed. Great care should be used not to tear or perforate the thin elastic mucosa. These steps leave a freely movable flap which may be placed in the position of the defect and sutured to place using a dermalon suture (0000) on a half-round atraumatic needle (Fig. 2).

The whole area is protected with a surgical pack. The manipulation of the pack is important as it must be placed in such a manner that the wound is not disturbed. If this is accomplished, there will be healing by first intention. The pack should be

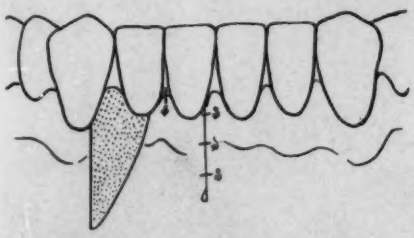

Fig. 2. Diagram illustrating sliding of flap to cover exposed root surface. S—Sutures. The shaded area is left to granulate.

of a soft consistency and rolled out into a long roll about the size of a pencil. The teeth are dried with a blast of warm air and the pack is laid on the labial surface of the tissue below the crowns of the teeth. The lip is used to adapt the pack, using a slight pressure in an inward and upward direction, forcing the pack between the teeth. Another, smaller roll is placed on the lingual surface of the teeth which locks the entire pack in place and affords more complete protection to the area of operation. Any excess is trimmed off to allow a free occlusion, preventing breakage of the pack. In these cases, an intramuscular injection of Bicillin was given in an effort to prevent secondary infection and to maintain the blood clot.

POST-OPERATIVE CARE

The pack is used to protect the wound from saliva, trauma and to provide a local analgesic action. The patient should be advised to refrain from unnecessary speech or manipulation of the lip and to remain on a liquid diet for the first seventy-two hours. The ultimate success of the procedure may hinge upon keeping the pack securely in place.

The wound is uncovered after three days to remove the sutures. The pack is broken into small fragments and removed piecemeal. Great care must be taken since suture ends may be embedded in these pieces. In this instance, the suture should be carefully cut between the pack and the tissue. When the pack is completely off, the rest of the sutures may be removed. The area is cleansed with a slight stream of warm water, exercising care not to pull on the lower lip. All the edges of the wound surface are cauterized with 30% trichloroacetic acid and immediately rinsed with warm water. The pack is replaced as previously described. The wound is cared for in this manner each week until healing is complete. The pack is left on for a period of twelve to sixteen days.

In approximately twenty-one to thirty days, the denuded area is completely healed by granulation and the area is epithelialized. No attempt should be made to probe the gingival sulcus for a period of sixty days.[4] Inasmuch as the new tissue is tender, the patient is advised to maintain oral hygiene with a soft multi-tufted toothbrush.

The following three cases illustrate the usefulness of the method described. Figure 3 shows the gingival recession localized to the right lower central incisor of a twenty-one year old male. The attached gingiva is completely missing; the gingival margin is loose and appears rolled. Much materia alba and hard subgingival calculus are present. The labial frenulum is relatively high and reaches between the two central incisors. The frenulum does not seem to be in direct relation to the gingival defect. The sliding flap operation and frenotomy were performed April 28, 1955. Figure 4 shows the result twenty-eight days postoperatively (May 26, 1955).

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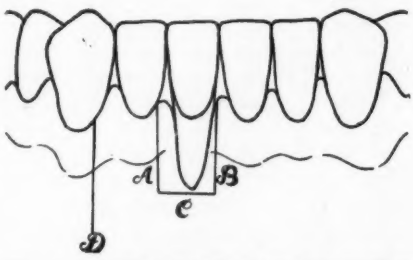

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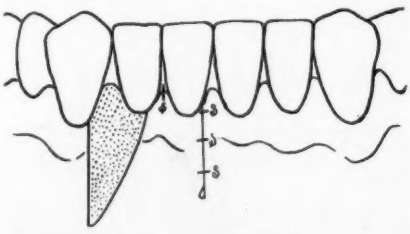

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Fig. 3. Exposed root surface on right lower central incisor. High frenulum. (Operation April 28, 1955).

Fig. 4. Same case as Fig. 3 on May 26, 1955.

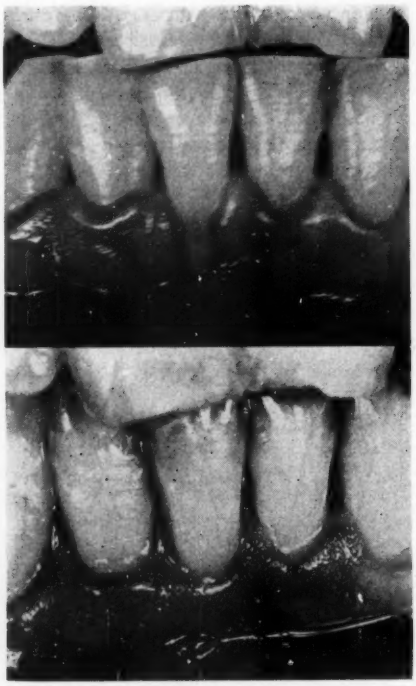

Fig. 5. Central mandibular incisor with receded gingiva. Operation performed March 22, 1955.

Fig. 6. Same case as Fig. 6 on April 21, 1955.

Another case is shown in Figure 5. The central mandibular incisor on the right side shows recession with inflamed gingival margins and an unhygienic situation. The frenulum in this case was not especially high. Operation was performed March 22, 1955 and the postoperative picture, Figure 6, was taken thirty days later—April 21, 1955.

The third case is that of a twenty year old male. The gingiva is receded on the right lower central incisor (Fig. 7), the gingival margin is swollen, rolled, and loose. The frenulum attachment is not particularly high, but it is attached incisally from the receded gingival margin. A sliding flap operation and frenotomy were performed March 18, 1955 and the postoperative result is shown on April 20, 1955,—thirty days after the operation (Fig. 8).

DISCUSSION

It is unfortunate that it was not possible to follow these cases for more than thirty days. At this time the gingival margin appeared in all cases to be pink, thin, firm. No exudate could be expressed from the gingival area. Probing was avoided because it was assumed that the attachment, if obtained, was still not too firm. An attempt will be made to check these patients at a later date, but the results to this time warrant reporting so that further and more extended observations can be made.

In contemplating such a plastic operation, the blood supply of the flap to be used is of great importance. The blood supply in the region of the gingiva of the lower incisors is three-fold:—from the mental arteries, the inferior labial arteries and the interdental arteries with rich anastamoses

Fig. 7. Right lower central incisor, with gingival recession. Operation March 18, 1955.

Fig. 8. Same case as Fig. 7 on April 20, 1955.

of these vessels.[5] There is a rich vascularity and elasticity in the area where the operation has to be performed, which renders the site favorable for this operation.

The gingiva and alveolar mucosa are the soft tissues of primary concern in this operation. The gingiva is that part of the oral mucosa which contains very dense connective tissue consisting of coarse collagenous bundles, and is immovably attached to the periosteum of the alveolar bone. The alveolar mucosa is a freely movable mucous membrane attached to the periosteum by a well defined layer of loose connective tissue containing numerous elastic fibers.[6] The hard tissue of concern is the cementum of the exposed root in the defect.

There has been much discussion in the periodontal literature for many years as to whether there is an actual gingival reattachment or whether there is merely a tightening of the crevicular epithelium producing a normal gingival crevice.[7] A true reattachment is, of course, the ideal result and much evidence shows this can be accomplished if an exact technique is carefully followed.[8] In some cases, true reattachment may not be obtained; however, a satisfactory result is still realized from a functional as well as an aesthetic point of view.

A similar operation could be performed in other areas of the oral cavity, combining this procedure with the use of bone implants (probably from a bone bank) in the area of recession. Circumstances have prevented such an attempt to this time.

SUMMARY

1. A sliding flap operation was used to cover up exposed root surfaces.

2. This plastic operation is often combined with frenotomy.

3. The time of postoperative observation of the cases presented was rather short and prevents final judgment of possible reattachment of the gingiva, but the results to date are promising enough to be reported for further development.

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Effect of Certain Factors Upon Toothbrush Bristle Stiffness

by MARJORIE L. SWARTZ, B.S.;* RALPH W. PHILLIPS, M.S.,** AND MAYNARD K. HINE, D.D.S., M.S.,*** *Indianapolis, Ind.*

THE relative merit of nylon and natural bristle toothbrushes is still controversial and the most desirable bristle stiffness has not as yet been determined. Basic information regarding the various factors which influence the stiffness of the brush is still needed.[1-6]

Macfarlane[7] studied nylon and natural bristles and found the stiffness of the nylon to be greater, at a ratio of approximately 3:4. Hine,[8] utilizing a Taber Stiffness Tester, measured the relative stiffness of various commercial nylon and bristle brushes. He found the stiffness of the nylon brushes to be somewhat more uniform than that of the natural brushes; however, little correlation was noted between the gradings of different manufacturers and the actual stiffness of the brush. In a clinical study devoted to the general problem of the effect of use upon the physical properties of nylon and natural brushes, Wade[5] found that there was less change in the stiffness of the nylon brushes. Although the nylon bristles did tend to bend or splay with prolonged use, many of the natural bristles fractured. This is not surprising in view of McCauley's[6] statement that the "bending endurance" of synthetic bristles is at least ten times as great as that of the natural ones.

It is known that the water sorption is less for nylon (3.3 per cent) than for natural bristles (7.0 per cent).[6] It is thus suggested, although not corroborated by scientific evidence, that this greater water sorption would produce a definite effect on the bristle stiffness when the brush is wetted during actual use. Since data pertaining to the effect of moisture upon bristle stiffness are most meager, the following in vitro investigation was initiated. The influence of this variable, and others, upon this property were studied.

PROCEDURE

The stiffness of nylon brushes is usually controlled by the diameter of the bristles. However, natural bristles are not uniform in either diameter or stiffness, so brushes of varying textures are produced by blending the bristles.[9] Since measurement of the stiffness of a few bristles would not be indicative of the general texture of the entire brush, it was necessary to devise a method whereby the overall stiffness of the brush could be evaluated. An apparatus was designed and fabricated for this purpose. It consisted of a "car" on which the brush head could be mounted in a fixed position. The car, running on a steel track, was propelled by a pulley with an attached weight. A copper crossbar was erected at one end of the track. This bar could be adjusted in such a manner that it would just contact the bristle tips. Then by means of a dial indicator it was turned down a known distance and thus exerted a constant load on all brushes. With the bar adjusted at this position, a certain force was required to pull the bristles beneath the bar and the stiffer the bristles, the greater the force.

Various methods for quantitatively determining this force were considered and attempted. One procedure was to vary the weight attached to the car and thus record the minimum grams required to pull the brush beneath the bar. This method is similar to that used by Hine[10] in studying "grip" of toothbrushes. However, a more convenient method for this particular study was to use a constant weight and vary the starting position of the car to which the brush was attached. The minimum distance,

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in inches from the starting point to the bar, at which the car had sufficient impetus to pass beneath the bar was recorded and used as the stiffness number. Naturally, the stiffer the brush the greater the distance required for enough momentum to be produced to pull the brush under the bar. Care was taken to release the car in the same manner to avoid differences in initial inertia. Control tests proved the method to be quite consistent and duplicate measurements could be repeated within $\pm$ 0.5 inches.

A group of specially manufactured nylon and natural bristle toothbrushes of a standard design were secured.* These were 50

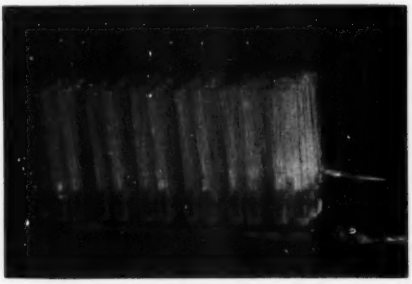

Fig. 1

tuft, four row brushes. Since Macfarlane[7] has shown bristle length to be a function of stiffness, the brushes were flat trimmed in order that all bristles would be of the same length. Thus, the only variable introduced was that of the bristle material. There were three groups of natural brushes, graded as hard, medium and soft and two groups of nylon, one made with .008 inch diameter bristles and the other with bristles of .014 inch diameter. A representative brush can be seen in Figure 1.

A minimum of six brushes were tested in each group and each brush was measured at least five times. The figures given in this paper represent the mean stiffness of all these tests.

*Courtesy Pepsodent Division, Lever Brothers Company.

RESULTS

Effect of Water on Bristle Stiffness

The stiffness of the three types of dry natural brushes and the .008 inch and .014 inch diameter nylon brushes was tested. They were then immersed in tap water for periods of one second, 30 seconds, 2 minutes, 4 minutes, 15 minutes and 2 hours. Immediately upon removal, the excess water droplets were shaken from the brushes and the stiffness measured. The brushes were then allowed to dry in air and the stiffness recorded at one, two and six hour intervals. The data may be seen in Table 1.

Examination of the original measurements reveal that the relative stiffness of the various nylon and natural toothbrushes, of the same design, can be readily determined by this test method. Readings on the hard and soft natural brushes were quite different; however, little difference was found to exist between the medium and hard brushes. The variation in stiffness of the .008 inch and .014 inch diameter nylon brushes was marked and the measurement for the .008 inch nylon was less than one-half that of the soft natural brush.

The stiffness of all of the natural bristle brushes was considerably reduced by immersion in water, even when the immersion time was only one second. It was particularly apparent in the soft brushes where the stiffness decreased approximately 40 per cent in that time period. This would seem to bear out the statement of Hine and Coolidge[11] that a person will start toothbrushing with a natural brush of one degree of stiffness and end the brushing with a much softer one. The data indicate also that the brush gradually returns to its normal stiffness as it dries. Although some brushes did not regain their original stiffness even after six hours of drying, all approached it. Generally, brushes which had been immersed for periods of 15 minutes or

Bristle Material	*Original Stiffness*	*Soaked in H_2O*	*Stiffness Immed. on Removal*	*Stiffness after drying* one hour*	*Stiffness after drying* two hours*	*Stiffness after drying* six hours*
	8.4	1 sec.	5.9	7.8	8.1	8.4
	8.3	30 sec.	5.9	6.6	7.0	7.4
Soft	9.4	2 min.	6.6	6.6	8.0	8.8
Natural	9.4	4 min.	6.3	6.8	8.3	9.3
	9.8	15 min.	5.8	6.0	7.0	8.0
	10.0	2 hrs.	5.9	6.4	7.1	7.5
	12.8	1 sec.	11.1	11.8	12.0	12.3
	12.1	30 sec.	9.0	10.7	11.3	11.4
Medium	15.2	2 min.	8.0	9.5	12.3	13.1
Natural	15.3	4 min.	7.8	9.4	11.5	12.6
	14.1	15 min.	6.5	7.3	9.0	10.5
	14.7	2 hrs.	6.8	7.7	10.2	12.1
	13.8	1 sec.	10.6	12.5	12.8	13.6
	14.4	30 sec.	10.7	12.8	13.2	13.7
Hard	15.6	2 min.	11.2	12.9	13.5	13.9
Natural	16.4	4 min.	10.1	12.9	13.1	14.1
	15.9	15 min.	7.2	8.0	10.9	12.5
	16.7	2 hrs.	6.8	9.8	11.3	13.0
	4.3	1 sec.	3.8	3.9	4.3	4.3
	4.1	30 sec.	3.5	3.8	4.0	4.0
.008	4.6	2 min.	3.6	3.7	4.0	4.3
Nylon	4.4	4 min.	3.3	3.5	3.9	4.3
	4.8	15 min.	3.5	3.6	3.8	4.1
	4.7	2 hrs.	2.5	3.2	3.6	3.9
	11.1	1 sec.	10.8	10.9	11.1	11.1
	10.7	30 sec.	9.1	9.5	9.8	9.9
.014	11.6	2 min.	10.5	11.0	11.3	11.6
Nylon	12.2	4 min.	10.4	11.2	11.7	12.1
	11.6	15 min.	10.1	10.5	11.0	11.3
	11.3	2 hrs.	8.0	8.4	9.3	10.2

*Dried in Air

TABLE 1

longer did not recover stiffness as rapidly as those soaked for shorter periods of time.

When immersed in water, the nylon bristles tended to retain their stiffness much better than the natural bristles and they also regained their original values more rapidly when allowed to dry. If the softening of the bristle is directly related to water sorption then this finding is not surprising since nylon does have a low water sorption.[6]

Naturally, the rapidity with which the toothbrush bristles would dry and regain their stiffness is dependent upon the humidity of the storage environment. To check this variable, another series of tests were made. After measuring the original stiffness, natural and nylon brushes were immersed in tap water for 30 seconds. Their loss in stiffness was measured. One group was then placed in a desiccator while another group was placed in a humidifier where they would be maintained at essentially 100 per cent humidity. The stiffness was tested after storage for six hours and again after 24 hours. The data appear in Figures 2 and 3.

The brushes, both natural and nylon, stored in a desiccator regained much of their original stiffness in six hours and exhibited complete recovery in 24 hours.

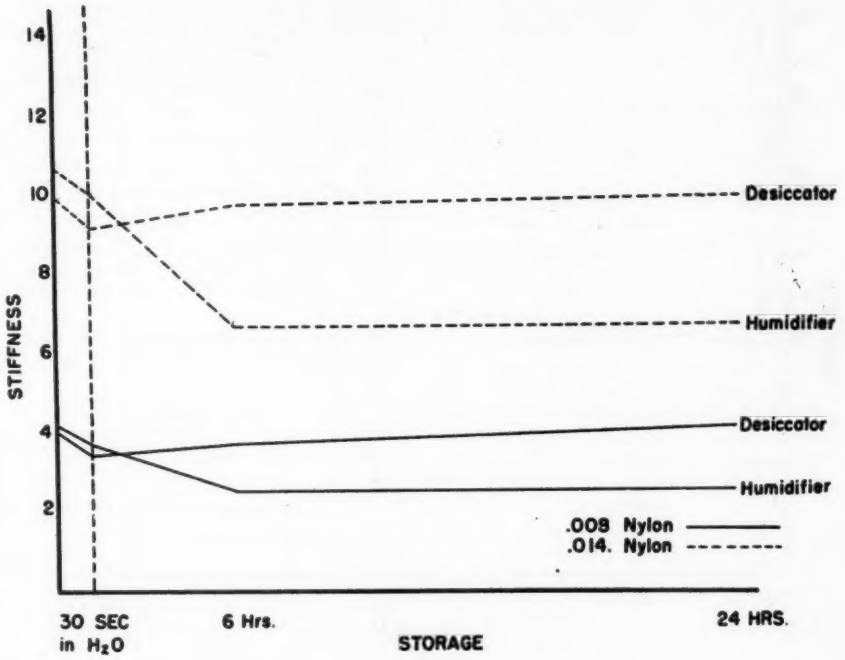

Fig. 2

Those stored in the humidifier actually became softer after six hours storage. Since no additional softening was noted at the end of the 24 hour period, it is apparent that saturation of the bristles had occurred at six hours.

From the practical standpoint, these data do indicate that, following use, if the toothbrush is to rapidly regain its normal stiffness, it must be stored in a dry environment. Storage in a closed container where it will be surrounded by water vapor will prevent drying of the bristles.

Influence of Lubrication

The study up to this point had indicated a definite effect of moisture upon bristle stiffness; however, the exact mechanism whereby the bristle became softened was not known. A series of tests were designed to determine whether the reduction was due to actual water sorption or merely to a lubricating action on the bristle surface.

A group of brushes were placed in a light machine oil for 30 seconds. After blowing off the excess oil, the bristle stiffness was measured. The brushes were then stored in air for 24 hours and measurements again made. The data can be seen in Table 2. It is evident that immersion in oil had no effect on stiffness. Thus, it appears that the previous data which showed a reduction of stiffness in water is not due to lubrication of the brush but is more likely a softening of the brush by actual water sorption.

Effect of Wear

The influence of use or wear on the bristle stiffness was investigated. A mechanical toothbrushing machine was utilized with a load of 230 grams placed on each brush. The brushes were carefully mounted in such a manner that the bristle

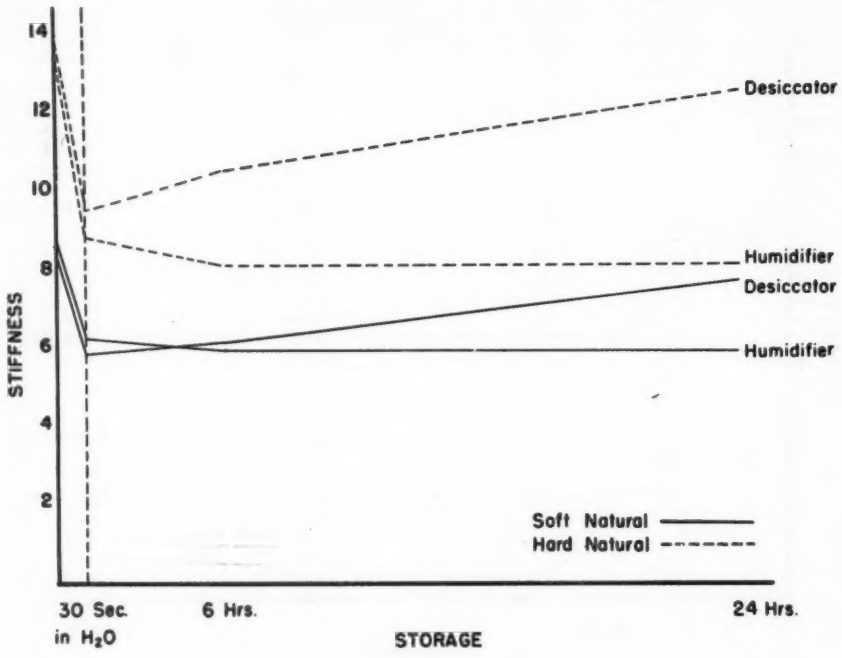

Fig. 3

ends rested flat on brass plates in the bottom of the pans. After 50 minutes brushing in tap water, the brushes were removed and placed in a desiccator for 24 hours before the stiffness was again measured. They were then returned to the brushing machine, run for another 50 minutes, dried for 24 hours and measured.

The data can be seen in Table 3. The natural bristle brushes were so badly splayed that it was not possible to evaluate the stiffness by this test method. The stiffness of the nylon brushes, however, was readily measured. Some loss in stiffness was noted. However, these data, and the visual observations made on the natural brushes, are in agreement with the clinical studies of Wade[5] who found a greater durability for nylon.

SUMMARY

A method of evaluating the relative stiffness of toothbrushes was devised. The influence of certain factors on this property was investigated.

The inherent stiffness of both nylon and

TABLE 2

Bristle Material	*Grade of Brush*	*Av. Original Stiffness*	*Soaked in Oil 30 seconds*	*Dried 24 hours*
Natural	Sott	7.8	7.8	7.8
	Medium	10.9	10.9	10.9
	Hard	11.5	11.5	11.5
Nylon	.008 dia.	4.1	3.9	4.0
	.014 dia.	11.4	10.3	10.3

TABLE 3

Bristle Material	*Original*	*50 min. brushing*	*100 min. brushing*
Soft Nylon	4.5	3.9	3.6
Hard Nylon	12.8	8.9	8.6

natural bristles was reduced by exposure to moisture. Immersion for periods of only one second resulted in an appreciable loss in stiffness. Both materials tended to regain stiffness with drying; however, nylon recovered with somewhat greater rapidity. This was, of course, accomplished more readily when the atmosphere was dry. Evidence was obtained to indicate that the mechanism for the loss in the bristle stiffness is due to sorption of water rather than a lubrication of the bristle.

Prolonged mechanical brushing produced some softening of nylon brushes.

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AMERICAN ACADEMY OF DENTAL MEDICINE ELECTS HONORARY MEMBERS AT TENTH ANNIVERSARY MEETING

Dr. Donald A. Kerr of the University of Michigan School of Dentistry and Dr. Edward D. Stafne of Mayo Clinic will be accorded Honorary Membership in the American Academy of Dental Medicine at its Tenth Annual Meeting at the Hotel Sheraton-Cadillac in Detroit, Michigan, June 21-24, 1956.

"Oral and Physical Manifestations of Systemic Disease" will be the theme of the 3-day scientific sessions, covering endocrine and nutritional disbalances, dermatologic and allergic disturbances, circulatory disturbances, radiologic manifestations, as well as laboratory tests of aid in oral diagnosis, and dental writing. Participating will be Drs. Robert L. Schaefer, Donald Kerr, Raymond Monto, Alice Palmer, Edward Stafne, William Umiker, and Jacques R. Gray.

A special Tenth Anniversary issue of the Journal of Dental Medicine, the Academy's official publication, will appear in April, highlighting the achievements of the first decade of the Academy's history and featuring many fine articles on oral medicine.

All members and other interested dentists and physicians are cordially invited to attend this Anniversary Meeting in Detroit. Address the National Secretary, Dr. George J. Witkin, 45 South Broadway, Yonkers 2, N. Y.

Radical Subgingival Curettage

by A. B. RIFFLE, D.D.S., *Rochester, N. Y.*

RADICAL subgingival curettage is a logical, definitely planned procedure for the treatment of periodontal diseases, made possible by the discovery of previously unrecognized deteriorations in the cervical area of human teeth. All forms of periodontal treatment stress the necessity for the removal of all calcareous deposits and organic debris, and the planing of the tooth surface to smoothness. Radical subgingival curettage does the same, but recognizes the impossibility of attaining this smoothness without removing some of the surface and all of a measurable amount of the enamel at the cemento-enamel junction;[1] the impossibility of curetting the cementum to hard smoothness without removing it in its entirety, and the undesirability of so doing, even if it were possible;[2,3] and the existence of, and the necessity for the removal of a characteristic area of softened dentin in the denuded root.[4]

At each sitting, the periodontist utilizing conservative subgingival curettage attempts to remove all calculus and roughness on many tooth surfaces, fully expecting to repeat the procedure at frequent intervals. Over a period of many years, by repeated removal of such surface layers, he performs the operation of radical subgingival curettage, without knowing he is doing so, or, if he does, thinking he has done something wrong. The operator using radical subgingival curettage stays on one surface of one tooth, until the operation is finished—all deteriorated tooth surface removed—accomplishing in one operation that which others spend years in doing. He does not expect to touch that surface again for many years.

The practitioner of conservative subgingival curettage is deeply concerned with calculus, as indeed it would seem he must, for he has noted that a recurrence of the gingival inflammations he is trying to combat are frequently accompanied by formations of calculus, or at least some material which feels like calculus to his curetting instrument. The periodontist using radical subgingival curettage is little concerned with calculus, removing it only when he also has the time to remove the deteriorated surface on which the deposit has formed, for he has learned that the calculus is actually less irritating than the surface it covers. He has also learned that though new deposits do form soon after early treatment, it actually falls off by itself as treatment progresses, or, when removed at a much later date, that it does not recur except in unsuccessfully treated areas (Fig. 1). He has also learned that the "gritty," "crunchy" sound and feeling to a sharp curetting instrument usually is not calculus; it is the deteriorated tooth surfaces we have described.

In short, radical subgingival curettage is a clearly defined operation on the tooth itself, whose objective is to restore the health of the periodontium by removing the foreign body that the tooth surface in the pathologic crevice has become.[1,2,3,4] Removal of the tooth is the most certain cure for the periodontal diseases around that tooth; removal of the part of the tooth that is the source of the irritation is the next best approach (radical subgingival curettage); removal of the surface irritants at frequent intervals the least effective of the three (conservative subgingival curettage). Other treatment, such as surgical removal of the soft tissues, occlusal adjustment, diet and nutrition, oral hygiene as usually practiced, etc., are only adjuvants which ignore the primary source of the chronicity of the trouble—the dead or dying, diseased tooth surface. Their use may lead to a temporary recovery, but all will fail unless this source of chronic irritation is also removed. On the other hand, removal of this deteriorated surface will

Fig. 1. Female—45 yrs. No prophylaxis or curettage since July 1942. History of rapid recurrence of calculus deposits since girlhood. In the author's practice since 1928, when, at 21 years she presented a grossly neglected mouth. The old amalgam fillings visible, and many others were placed at that time. Our clinical memory, and that of the patient, is one of repeated caries, edematous and hemorrhagic gingivae, and general periodontal deterioration until the late 1930's, when radical subgingival curettage was started. Since 1940, there has been little new caries. The devital lower right bicuspid was recently extracted as a health measure. The entire mouth has continuously presented the same general picture of cleanliness and health for several years.

usually succeed without resort to the others.

THE TREATMENT

There are three objectives in radical subgingival curettage: I. The removal of all deteriorated and undermined enamel in the cervical area. II. The complete removal of all denuded cementum. III. The removal of all softened dentin.

I. The Removal of the Deteriorated Enamel. With firm pressure, repeatedly pass a sharp curette, plane, sickle scaler, or even a chisel or spoon excavator over the "crusty" enamel adjoining and beneath the gingival margin, repeating the planing and scraping in all directions until the sharp instrument glides over the surface without audible or tactile roughness.

This consistently results in the loss of varying amounts of enamel, from a barely detectable surface crust to a visible band of surface loss and usually results in a complete loss of the enamel at the cemento-enamel junction. In some cases the amount of this loss is quite alarming (Fig. 2—upper right cuspid and lateral incisor), particularly when the enamel is undermined as described below. In most cases it averages about 1 mm. in width[1] (Fig. 3—upper right and upper left first bicuspids, cuspids, and lateral incisors).

Our studies of extracted teeth began around 1940, and at the same time we were spending an ever-increasing number of chair hours in the treatment of periodontal lesions. During the day we were curetting tooth surfaces in the mouth; in the evening, the extracted teeth. Observations on the character of the enamel of extracted teeth and findings at the chair coincided perfectly, and from these were formulated a set of rules: (1) Calculus is rarely found in early gingivitis. (2) A definite crustiness of the surface of the enamel is always present adjoining and beneath inflamed gingivae. (3) Superficial removal of this

Fig. 2. Female—85 yrs. History of over 30 years of frequent conservative subgingival curettage before entering the author's practice in October of 1942. At that time all teeth were definitely mobile and sensitive, the gingivae soft, flabby, and chronically hyperemic and hemorrhagic, and the crevices deep. The upper right central and lateral incisors and cuspid have not been curetted in our office; the upper left central and lateral have received radical subgingival curettage, as have most of the other teeth. Obviously the end result on the tooth is the same. For several years the entire mouth has been clean and comfortable, the teeth are firm and not sensitive, the gingivae are thin, tough, and firm, and the pathologic crevice practically non-existent, except for the lower anteriors. Here, the lower right central and lateral incisors actually fractured from the deep penetration into the tooth, and being unable to curette to the hard, uncuttable smoothness on the others, only a fair degree of gingival health has been attained.

The upper right cuspid and lateral incisor are good examples of the extreme loss of enamel that sometimes occurs. The upper left central incisor, and the upper right central and lateral incisors illustrate the penetration into the dentin to a depth that the former location of the pulp is exposed.

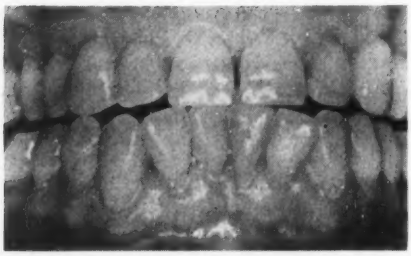


Fig. 3. Female—39 yrs. Clinical observations May 1946: All teeth slightly to definitely mobile and sensitive to cold and sweets. Gingivae habitually swollen and engorged, of a magenta hue, repeatedly hemorrhagic during brushing and excessively so during the first sittings of radical subgingival curettage. Repeated scaling and thorough curettage over a period of several years previously had resulted in no more than temporary improvements in clinical health.

Diagnosis: Advanced Chronic Hyperemic Periodontitis.

Treatment: Radical subgingvival curettage at irregular intervals from May 1946 to April 1951, when the photograph was taken. Patient failed to cooperate on recommended frequent and regular visits, receiving 7 treatments in 1946, 7 in 1947, 6 in 1948, 9 in 1949, and 4 in 1950.

Comment: Less than one half of the tooth surfaces in this mouth have been curetted. No prophylaxis or other treatment. Still, we have marked improvement in the health of the entire mouth. For example, the lower right first bicuspid has been curetted on the buccal; the lower left first bicuspid has not, with almost the same reduction in inflammation and pocket depth in both. Note, however, that there is beginning cervical caries on the untreated left and none on the treated right. Also notice the shiny, hyperemic gingivae over the upper right central incisor (untreated) when compared to the other upper anteriors which have received radical subgingival curettage.

crusty surface by light scaling, polishing with pumice, etc., frequently results in some improvement in the health of the gingiva, but these benefits are temporary. (4) Complete removal of this crusty surface, even to the loss of a measurable amount of the enamel at the cemento-enamel junction, gives a more permanent improvement in the health of the overlying tissues (Fig. 4 A & B). These rules are still sound after over ten years of clinical application.

In both early gingivitis and late periodontitis, a common cause of treatment failure seems to be a lack of thoroughness in removing the deteriorated enamel surface. Another, that we have failed to remove in its entirety the overhanging ledge of enamel and the softened dentin beneath, as described in previous studies.[4] In the latter, failure to remove the softened dentin under the enamel results not only in poor periodontal health, but usually the remaining softened dentin becomes carious soon after the receding gingivae exposes the area to the mouth. Caries rarely occurs if all of the softened dentin is removed. Thus, in Figure 3 the lower right first bicuspid had been curetted 4 years previously and is caries free, while the lower left first bicuspid which had not been curetted is showing carious softening.

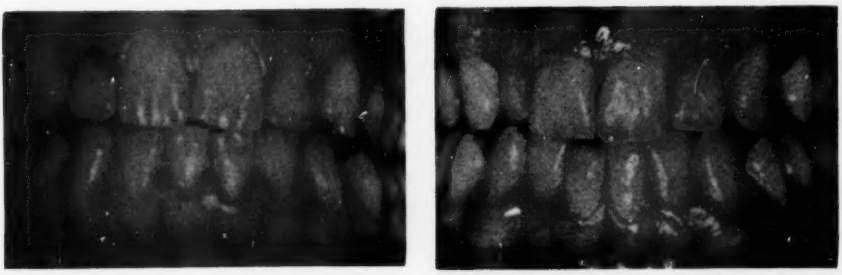
Removal of this softened dentin under the enamel, leaves a sharp shelf of enamel standing out away from the remaining healthy dentin, the same pattern so commonly seen in wedge shape abrasions. Here, the judicious use of sandpaper disks and stones, and of abrasive strips (Lightening Strips) interproximally, serves to contour the sharp edge to a more pleasing and self-cleansing saucer shape (Figs. 3, 8, & 9).

The removal of the deteriorated enamel is a slow and difficult process, requiring tedious persistence on the part of the operator, and it can be exceedingly time-consuming. After watching the outcome of this procedure, however, and comparing it with attempts to treat early gingivitis by a less thorough scaling and polishing, we have concluded that despite the time consumed and the effort involved, the comparative permanence of the return of tissue health makes the effort definitely worth the while.

In gingivitis, this is all there is to treatment; in periodontitis, where the soft tissue attachment has passed beyond the cemento-enamel junction, it is the first step in radical subgingival curettage. It is as important as thorough curettage of the root surface.

II. *The Removal of All Cementum.* With firm pressure, repeatedly pass a sharp curette, plane, or sickle scaler over the denuded root surface.

Where possible a "pull" stroke is most effective and least distressing to the patient. Start the planing stroke as deep in the



A B

Fig. 4. Female—21 yrs. at **A** and 23 yrs. at **B**. Edematous, hemorrhagic gingivae around upper and lower anteriors (**A**) in December 1949, when radical subgingival curettage was started, restored to health in November 1951 (**B**). Probably an acceptable degree of normalcy was attained several months before this, but picture in 1950 still shows some pathology, particularly around the upper right later and the lower left central incisors, where the return to normal was discouragingly slow. No further treatment was instituted during this interval. The deteriorations were entirely on the enamel and the cemento-enamel junction was not involved.

pathologic crevice as the patient's comfort will allow, pulling the scraping edge over the cemento-enamel junction. In some areas, the "push" stroke is a necessity. On these, the stroke starts on the enamel and passes as deep into the pathologic crevice as the gingivae will allow. Frequently both "pull" and "push" strokes are advantageous in the same area.

On the teeth of the young, and on those of a very few individuals in later life, the glassy hard smoothness desired will be reached with only a few strokes of the sharp instrument. Even on these, however, the studies on extracted teeth demonstrated that exposed cementum will be removed in its entirety, and a slight thickness of dentin as well.[2,3] On most teeth, when the attachment of the periodontal fibers has passed the cemento-enamel junction, the "gritty," "crunchy" sound and feeling will continue well into the dentin, particularly in the area of the cemento-enamel junction.[4]

At the bottom of the pathologic crevice, on all teeth, little but the cementum will be removed, the dentin being only slightly affected. Ordinarily this area is not reached in the beginning, and frequently cannot be reached until the removal of the deteriorated enamel, the dead cementum, and part of the deteriorated dentin gives access to the tooth surface adjoining the remaining soft tissue attachment.

The removal of the cementum does not require the force or persistent effort that is required in removing the deteriorated enamel. Even on freshly extracted teeth, the cementum over the entire root is soft and readily planed and scraped away.[3] Cementum on teeth long exposed to the contents of the pathologic crevice is even softer, feeling as if the instrument were penetrating a piece of soft wood, and presenting no hard "gritty," "crunchy" sound or feel whatsoever to the first strokes of the instrument. All cementum is softer than subgingival calculus, but the sound and feel of the instrument is no different from that of the dentin immediately beneath and it is impossible to detect when one stops curetting cementum and starts curetting deteriorated dentin. Healthy dentin is so hard, smooth, and almost uncuttable that there is little likelihood of mistaking it or little chance of "cutting too deep." And let us remember that frequently there is no cementum present on parts of many teeth before curettage starts. Also let us repeat that cementum is never sufficiently hard and resistant that it will remain a permanent or even a reasonably long-lived protective covering for the root surface.[2,3] It is dead bone; as such it is a foreign body and should be removed.

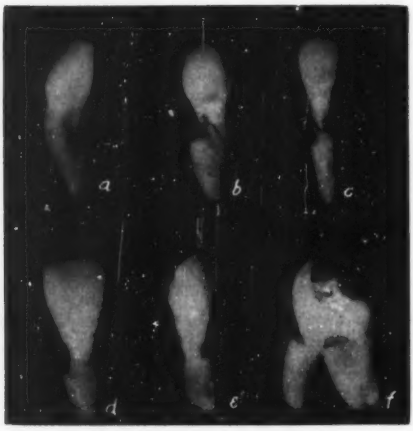


Fig. 5. Teeth lost following repeated attempts to "remove calculus" and plane the root surface to smoothness before radical subgingival curettage was inaugurated in the author's practice. **a** (female—45 yrs.) Pulp exposure. **b** (female—40 yrs.) and **c** (female—23 yrs.) Pulp exposure and fracture while still in the mouth. **d** (female—49 yrs.), **e** (female—49 yrs., and **f** (female—34 yrs.) Ledge formation at the bottom of the pathologic crevice. **f** also presents an exposed pulp.

III. *The Removal of All Softened Dentin.* With firm pressure, continue passing the sharp instrument over the surface of the root in the pathologic crevice, until a hard, glassy surface is encountered in every area; until there is no "grittiness" to be felt or heard, from the bottom of the pathologic crevice over the new dentino-enamel junction formed by the removal of the cementum and the deteriorated enamel. Be certain that no "ledge" of tooth remains at the bottom of the pocket. (Fig. 5 d, e, & f; Fig. 6 A).

As described in our studies of the dentin during curettage[4] there may be little or no penetration into the dentin in early mild cases, or even on parts of more seriously involved teeth, the continued curettage resulting in little more than the removal of the cementum and an accentuation of the cemento-enamel (dentino-enamel) junction. This is fairly common before twenty-five years of age; rare after thirty-five.

On most teeth, however, when the bottom of the crevice has passed beyond the enamel, the sharp instrument will detect marked softening in the area of the cemento-enamel junction and the removal of this deteriorated area will result in a definite characteristic pattern—that of a wedge shape abrasion. As a general rule, the softer the surface, the deeper the penetration into the tooth, but there are exceptions. For example, one does find teeth whose outer surface seems quite hard and resistant to the scraping from the very start, yet they develop rather deep characteristic grooves. Rarely does a marked softening of the surface result in anything but a deep penetration, and as previously described,[4] exposure of the pulp is possible in the carious and the markedly softened. (Fig. 5 a, b, c, & f).

Another general rule: The older the patient = the deeper the pathologic crevice = the softer the surface = the deeper the penetration. Before thirty-five years of age, the penetrations will be dangerously deep only in those so-called "periodontosis" cases in which the ravages of the disease have been unusually severe. After fifty years, 38% of our extracted teeth showed these pulp exposures and actual fractures, before the hard, glassy smoothness was attained. These were extracted teeth, however, most of which had been lost because of periodontal involvements, and the frequency of this complication in the mouth is much smaller. Meeting this situation will be discussed under "Local Complications During Treatment." Interestingly, in the younger "periodontosis" group, the pathologic crevice is usually quite shallow, despite the deep penetrations into the tooth.

A complete understanding of radical subgingival curettage is impossible without a thorough knowledge of the studies on which it is based,[1, 2, 3, 4] and the reader is here urged to read them. Every moment spent in curetting the surface of a tooth is made easier, more understandable, more efficient, and more effectual if the operator is thinking in terms of the characteristic pattern, the line of deepest penetration, the area of deepest penetration, the area of lesser penetration, the amount of penetration at the bottom of the pathologic crevice, the incidence of these various characteristics, and their variations from patient to patient, tooth to tooth, and from surface to surface of the same tooth.

For example, we have just mentioned that the dentin feels softer to the instrument at the cemento-enamel junction. From our studies we know that the deepest penetration into the tooth structure will take the form of a line, circumferentially around the tooth, slightly apical to, but otherwise coinciding with the site of the original cemento-enamel junction. This is the line of deepest penetration. Usually, also, the dentin is softer on one surface of the circumference of the tooth than on the others and continued curettage will demonstrate that this area is not only softer to the instrument in the beginning, but continues to curette more easily in a wider and deeper area than the adjoining parts. This is the area of deepest penetration. It is at the direct center of this area of deepest penetration that pulp exposure will occur if the softening goes that deep, and this direct center will be in the line of deepest penetration.

It was because of the complexity of presenting this new thought that the four previous articles were devoted to the basic knowledge required for an understanding of radical subgingival curettage. At the chair, the area of deepest penetration will usually be found in the area on the tooth showing the greatest degree of clinical involvement—the exact area in which the depth of the pathologic crevice, the thickening of the gingivae, and the degree of activity of the inflammation calls the operator's attention to the presence of pathology. It will help to know that in most cases before thirty-five, the deepest penetrations (and the greatest degree of clinical involvement) will be found on the labial/buccal surfaces; that in later life they will be equally as common on the palatal/lingual; and that rarely will these penetrations be as great on the proximal surfaces as on the others.

In addition to incomplete removal of the deteriorated enamel and the softened dentin beneath, as mentioned above, an additional common cause of failure following treatment is a lack of success in carrying the outline of the characteristic pattern to a smooth, tapered contour at the bottom of the pathologic crevice. It is difficult, if not impossible, to reach the bottom of many periodontal pockets at the beginning of curettage. As the scraping progresses, instead of reaching all of the way to and beyond the remaining epithelial attachment, the instrument forms a ledge within the tooth structure itself (Fig. 5 d, e, & f; Fig. 6A). Formerly we tried to avoid this ledge formation, but now find that this natural sequence of events can be turned to our advantage. We permit this ledge to develop and it forms a natural painless "stop" for our curetting instrument during the process of scraping the rest of the tooth surface to be hard, uncuttable smoothness so desired. Then, and only then, do we carry our instrument point incisally/occlusally, out and over this ledge, continuing the process until we are certain that the smoothly contoured taper of the characteristic pattern has been obtained (Fig. 6B).

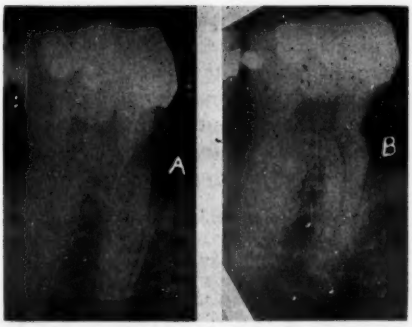


Fig. 6. **A**—x-ray negative of the ledge which frequently develops at the bottom of the pathologic crevice during curettage (much deeper than most). **B**—after proper curettage.

The strokes of the instrument might be described as: (1) carrying the point to the bottom of the groove; (2) with light pressure toward the soft tissue, drawing the instrument point back out of the pocket until it is felt to slip over the edge of the ledge into the soft tissues; (3) letting the point again fall apically until contact with the soft tissue at the bottom of the crevice is felt; (4) exerting firm pressure against the surface of the tooth, breaking in the overhang of the ledge; (5) continuing this until the ledge has been completely removed all around the bottom of the day's operated area; and (6) reversing the instrument to a direct "push" stroke out and over the former ledge area and into the soft tissue, removing the epithelial attachment and planing the remaining fine rough edges to perfect smoothness. Fortunately, the depth of the penetration into the tooth structure is usually not deep at the bottom of the pocket and a comparatively few skillful strokes at the very end of the sitting serve to accomplish this last step. Failure to remove this ledge will result in an area which will not return to clinical health, and *must be accomplished successfully.* Failures following years of conservative subgingival curettage frequently can be turned into successes by this one step, alone.

Do not disturb the blood clot after this final planing. The microbiologist continues to tell us that reattachment of the soft tissues is possible. We do not plan on this, though we have many cases where it would seem from clinical observation that such a result had been achieved. We do know, however, that a good blood clot is nature's own best protection for injured surfaces and wish to preserve it as long as possible during the recovery period.

THE INSTRUMENTS

Any sharp curetting instrument, small enough to reach the deepest areas of the

periodontal pocket, strong enough to withstand quite considerable pressure on occasion, of a design that is comfortable to the operator's hand and yet delicate enough to detect the slightest roughnesses on the tooth surface is acceptable. Each operator seems to have his own preference.

We prefer the 7S Sickle Scaler for all of our final finishing, and most of the routine of removing the rest of the deteriorated tooth surface (Fig. 7). It is theoretically possible that every surface of every tooth could be reached and curetted with this one instrument, though other instruments are more efficient in removing some of the softer areas. To us, there seems an advantage in training our fingers to use one instrument in preference to several instruments—the advantage of a matched set of golf clubs over a mixed set. Repeated daily searchings and curettings with this one instrument so educates one's sense of touch that the instrument becomes a part of the operator's fingers—a projection of his coordinated senses.

The instrument is at its best when new (Fig. 7A). The ideal would be a new instrument for each patient, for the shortening that accompanies repeated sharpening dulls the delicate response to each minute bit of roughness on the tooth surface. It is a temptation to use them until the blades become quite short and many men seem to prefer them this way (Fig. 7C). The best compromise is to use the shorter ones during the early removal of the deteriorated enamel and in the first stages of root curettage, another scaler, not quite new but longer and finer than the first for the intermediate scraping (Fig. 7B), and a new or almost new one for the final detection of the last fine roughnesses and the final finishing of the deepest areas of the crevice.

This scaler is not balanced in the sense that the cutting edge (the side of the point) is in line with the shank, nor do we find this a disadvantage. In fact, we suspect that being off balance adds to the delicacy of its sense of touch and magnifies the roughnesses we are seeking. We know that when we think we have carried curettage to completion with other instruments, the 7S Scaler will usually detect still further "grittiness." We know of no other instrument with which we can feel so certain that the true bottom of the crevice has been reached and the epithelial attachment removed.

The functioning part of the blade is the "side of the point." It is not a cutting edge, designed to *plane* the tooth surface; it is a *scraping* edge, designed to remove only the most minute thickness with each stroke. (Not the blade of a plane, but the scraping edge of a broken piece of glass). Therefore, a cross-section of the blade is almost square, presents four scraping edges and each scraping edge may be used with both the "pull" and the "push" strokes—eight potential directions of use.

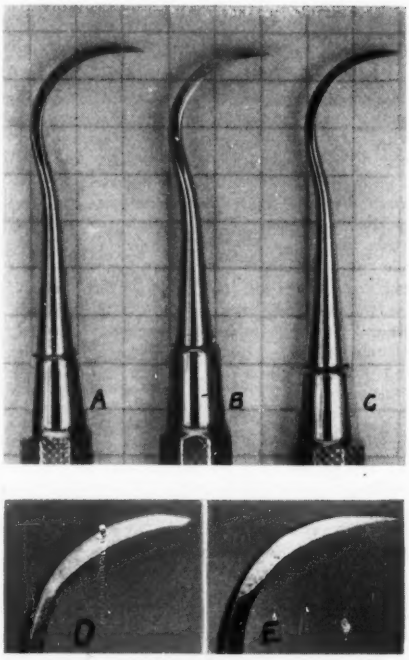


Fig. 7. The 7S Sickle Scaler. **A** is a new instrument; **B**, one that has been used but slightly shortened from constant sharpening; and **C**, one that will soon be unserviceable—too short for the delicate touch needed to detect the last fine roughnesses on the tooth surface. **D** illustrates the deflected point which frequently follows repeated sharpening; **E** the proper contour of reshaped point.

Not the least advantage of the 7S Scaler is that the sound of the instrument removing the roughened surfaces seems to be less objectionable to the patient than the heavier, cutting edge instrument, and it is usually less painful as well.

As has been emphasized since the earliest of writers, *the instrument must be sharp*. Scraping with a dull instrument is wasting time and effort. Sharpen the instrument every time the patient spits, and let him spit often. The sharpening stone is as much a part of the equipment on the tray as the instrument itself.

The 7S Scaler is easy to sharpen. We prefer the "soft" Arkansas Stone to the "hard" type ordinarily used. It gives a coarser edge, which we believe engages the softened tooth better than the usual edge. Two or three strokes on the side of the point which has just been used is usually enough to bring

the edge back to its original keenness. As the instrument wears, and the blade becomes shorter, it also becomes thicker and the scraping edge of the point is no longer in a straight line with the rest of the blade (Fig. 7D). Thin the instrument and restore an even contour to a definite point (Fig. 7E). We prefer a medium garnet disk for this. This thinning and pointing is not only a necessity for accurately searching out the contours of the root surface; it also adds materially to the patient's comfort, for if the working point is not a continuous surface with the rest of the blade, the scraping is no longer being done with the side of the point, but with the side of the instrument next to the deflected point, while the point is gouging the adjoining soft tissues.

For efficiency in the early stages, we do use Towner planes, Gracey curettes, and McCall curettes, and even cleoids, discoids, and spoon excavators on occasion. All are cutting instruments, and they will remove definitely softened dentin, particularly at the cemento-enamel junction, faster than the scraping edge of the 7S Scaler. They are also considerably more painful and objectionable to the patient.

LOCAL COMPLICATIONS DURING TREATMENT

Pain is the outstanding complication: (1) Pain in the tooth itself; (2) Pain in the surrounding tissues; and (3) psychogenic discomfort, engendered by the objectionable sounds, the sight of blood, and the knowledge that a form of surgery is being experienced.

Diagnosis is not the subject of this paper, but some points are necessary for clarification of our discussion of pain. Periodontal diseases are not just the clinical picture of the gingivae, the depth of the periodontal pocket, the mobility of the teeth, and the x-ray evidence of the amount of bone loss. There is also the factor of changing degrees of activity of the lesions on different days, and the frequency and the severity of these periods of active illness. Periodontal diseases are not static. They do not progress in an even fashion—each day a minute bit worse. Rather, they are characterized by exacerbations and remissions. Today the disease is quiescent and the mouth presents an acceptable appearance of health and cleanliness and the teeth are firm and quite insensitive to cold and sweets; tomorrow the lesions may be active and the mouth inflamed, dirty-looking, sensitive and uncomfortable, and the teeth markedly mobile. Then, usually in a few days or a week or two, a condition of reasonable clinical health is reestablished, without treatment.

The degree of sensitivity is an excellent indication of the degree of activity of the disease on the day of treatment. It is wise to treat teeth on which little sensitivity is foreseen on the "sensitive days"; the ones expected to be more sensitive on the "less-sensitive days."

In a previously untreated mouth, the first sittings are the most painful. As the mouth improves in health, as it will after a few sittings, the sensitiveness decreases, and the problem of acute discomfort disappears. The operator may reassure the patient that this will be the case; otherwise, few patients would continue treatment. After several sittings, radical subgingival curettage is comparatively comfortable to both patient and operator. The patient arrives for his appointment without marked dread or apprehension, converses pleasantly with the operator, jokes about his minor discomforts, and returns to his normal day's routine. He suffers far less than during the average sitting of either thorough prophylaxis or conservative subgingival curettage, both during treatment and after.

In the beginning, however, pain in the tooth itself can be a major problem. Some teeth are so exquisitely sensitive, even before any treatment whatsoever, that the patient is unable to tolerate cold or sweets, or even to brush his teeth in comfort. The slightest cooling from the compressed air tip will result in a marked attempt on the part of the patient to "pull away" as he rewarms the area. Obviously an attempt to curette such an area would seem to require heroic skill and patience. Were it not for a situation which we do not recall seeing in print or being previously noticed, curettage of these areas would be impossible without anesthesia, except for the most hardy. *These sensitive areas do not*

remain hypersensitive as curettage progresses. The first stroke of the instrument on each new area is almost unbearable—painful at times to the point of tears; the second stroke is not as painful as the first; the third even less; and in a few strokes more the area becomes only mildly uncomfortable or even completely painless. Since learning this, we rarely use local anesthesia for curettage, feeling that the early discomfort is less distressing to the patient than the anesthetic.

(1) *Pain in the Tooth.* During curettage of the enamel there is no pain in the tooth, except where the deteriorations are so deep that the enamel is lost in its entirety, or where the deteriorated dentin so undermines the cervical edge of the enamel cap that the overlying enamel is lost in its removal.[4] When this occurs, the dentin immediately beneath is the most exquisitely sensitive of any part of the tooth in the pathologic crevice area, and the final contouring of the overhanging ledge of enamel may have to be delayed until the sensitiveness disappears with time.

On the cementum, the first strokes of the instrument are painless, for the cementum is devoid of any means for the transmission of pain. If there is sensitivity at the first stroke of the instrument, the cementum is already gone[2,3] or so little remains that this first stroke removes it.

Immediately beneath the cementum lies the granular layer of Tomes, and this area is much more sensitive than the dentin beneath. Fortunately, this layer is also only about the thickness of a human scalp hair, and easily removed (and probably is removed in every case where curettage is carried to the desired hard, glassy smoothness). Then, as described above, the degree of pain rapidly decreases as curettage progresses, though this factor varies from patient to patient, from tooth to tooth, and from day to day, depending on the activity of the disease on that particular day.

The most painful and the most dreadful complication of radical subgingival curettage is pulp exposure. In our studies of extracted teeth, we demonstrated that 38% of them had dentin deteriorated to the extent that pulp exposure and fracture occurred before the desirable hard glassy smoothness was attained.[4] Many of these were teeth extracted for periodontal lesions—much worse than those usually encountered in periodontal treatment—but still pulp exposure is a dreaded possibility and must be expected on occasion and avoided if humanly possible. If exposure occurs, the patient will let you know at once. The pain is agonizing. He will describe it as a "red hot iron"—a "lightning" stab of pain.

The author has saved the pulps of a few of these by: (1) Preparing a retentive cavity around the exposure, pulp capping, and filling with a suitable restorative material. This is usually impossible at the time of the exposure, for the area is beneath swollen, bleeding gingivae and inaccessible, unless the gingivae are removed, and even here, the control of hemorrhage makes the procedure difficult. Also, the exposure usually occurs at the end of a sitting, and in a busy office, there is insufficient time to carry out the essential details; (2) Establishing of some retentive form and filling with a stiff mix of reagent zinc oxide and eugenol is frequently successful. When well placed, and often when placed under the most trying conditions, these serve to prevent immediate discomfort, until proper pulp capping and restoration can be accomplished. Frequently we leave these temporary fillings for months when we are sure they have been clean and dry at the time of placing, until the gingivae have receded and the tooth has recovered from its immediate post-operative sensitivity. On occasion it is impossible to obtain sufficient retention and this necessitates tying the zinc oxide and eugenol dressing to the surface of the tooth with ligature wire or dental floss. We have been only fairly successful with this latter approach, but have saved a few otherwise unsavable pulps. (3) Devitalization may be resorted to, either at the time of the exposure, or after deciding that the pulp capping has been unsuccessful. (4) Extraction is necessary at times.

Such pulp exposures and fractures are not limited to radical subgingival curettage. Figure 5 presents 6 extracted teeth, all accidents resulting from repeated curetting of the root during conservative subgingival curettage. *a* (female—45 yrs.) is from the practice of a periodontist of 40 years experience, who reports this has happened to him many times over the years. *b* (female—40 yrs.) and *c* (female—23 yrs.) are from the author's practice of about 15 years ago, following repeated attempts to plane the root surface to a hard velvety smoothness. The fractures occurred in the mouth. *f* (female—34 yrs.) not only demonstrates an unusually deep ledge formation at the bottom of the pocket, but an exposure as well.

Obviously it is much easier and wiser to avoid pulp exposure if possible. Here our knowledge of the characteristic pattern[4] is invaluable. As mentioned before, exposure usually occurs first at the very deepest part of the area of deepest penetration, slightly apical to the original location of the cemento-enamel junction.[4] In very old, long-standing cases, exposure may take place farther toward

Fig. 8. Female—50 yrs. Missing upper teeth extracted for periodontal reasons, March 1935. Conservative subgingival curettage 2-4 times a year from February 1935 to June 1944 failed to produce periodontal health, as evidenced by the extraction of the missing lowers in October 1941. Radical subgingival curettage started June 1944. The upper anteriors have not received any prophylaxis or other office care since October and November of 1944; the labial of the lower anteriors since 1945 and 1946. Photographed April 1950. History of constantly recurring calculus and several new carious lesions a year changed to no fillings during this period except the replacement of old silicates. No calculus has formed.

The lower left cuspid carried a large gold inlay on the labial root at the start of treatment, and the dark area is an arrested carious lesion which has remained unchanged for at least six years.

the apex as well (Fig. 5a), though even in these the first exposure will usually be as above. So, if the operator feels he is nearing a possible exposure, he carefully avoids the deepest part of the area of deepest penetration, curetting on all sides of this area to the hard glassy surface he desires, but leaving this very deepest portion incompletely curetted. He then waits and watches, frequently for a year or more. If the rest of the curettage has been successful, he will be rewarded by having this area completely visible and probably a new layer of secondary dentin beneath the exposure that would have been (Fig. 2). Some of these incompletely curetted areas become carious soon after exposure to the mouth and must be examined rather frequently (Fig. 3—lower left first bicuspid, buccal). Others remain little changed for long periods of time (Fig. 8—lower left cuspid, buccal).

Teeth which have been exposed for many years to the contents of the pathologic crevice and to the fluids of the mouth (advanced periodontal diseases in the elderly) and some teeth in the severe cases known as "periodontosis" in the young, actually have such deep loss of tooth structure completely around the tooth that fracture of the crown from the root occurs at the line of deepest penetration (Fig. 5, b & c).

Such penetrations present an almost impossible complication and if the operator feels such a situation exists, he might better advise extraction at once than to attempt treatment. If the softened dentin is not removed, periodontal treatment will fail; if removed, the tooth will fracture. Some of these can be devitalized, and a post crown placed, but when such excessively deep softenings are present on one or two teeth, they will usually be found on several others and present the possibility of almost endless complications. If such a situation is suspected, explain it carefully to the patient. Should the patient still wish to try, consider the first few sittings as diagnostic, while the operator determines the degree of softening on several teeth. Again inform the patient of the situation and warn him of potential failure. Radical subgingival curettage is too time consuming, arduous, and expensive to try the impossible.

After curettage, the patient usually is conscious of mild to severe discomfort from hot and cold, sweet and sour. This is more likely to manifest itself in from a week to five weeks after treatment than during the first few days. Probably the blood clot remains intact at first and acts as a protective covering; then, as the clot is lost and the enlarged gingivae return to normal, the curetted surface is exposed to the mouth with resulting discomfort. Warn the patient to expect this. Most patients accommodate themselves without undue inconvenience, and if warned, accept the situation with little complaint when reassured that it is not permanent. It does take several weeks for the sensitivity to disappear and occasionally, months. When complete recovery does occur, the patient will report his teeth less sensitive than he can remember, as long as periodontal health is maintained—as comfortable as the cervical wedge shape abrasion.

In spite of this return to comfort in the presence of hot, cold, sweet, and sour, however, these recently curetted surfaces are extremely sensitive for long periods of time if additional curettage is attempted. *Do not touch these previously curetted areas for months after radical subgingival curettage; the pain is unbearable.* Do not curette additional areas on the same tooth for months. Do not attempt cavity preparation in that tooth for months. Gentle cooling with room temperature air will help determine the progress of the decreasing sensitivity; avoid that tooth if possible until quite a stream of air produces little or no discomfort.

We have been singularly unsuccessful with the application of such drugs as silver nitrate, formalin, sodium fluoride, etc. So few patients make sufficient complaint about the discomfort that we rarely attempt their use.

Were we operating many teeth at a time, our patients' mouths would soon be so sensitive that they would not tolerate the situation, just as many patients refuse the repeated sittings of conservative subgingival curettage because of the increasing amount of pain that results from recently curetted areas being planed again and again. Operating on

one tooth, or a part of one tooth at a time, however, as is the practice in radical subgingival curettage, the patient readily adjusts himself to avoiding that tooth and when he reports sensitivity, we operate on a tooth in the immediate vicinity, keeping one area of his mouth free from recently operated areas, while the sensitive ones recover.

Curette one area, even if only a part of one tooth. Curette it to complete removal of all deteriorated tooth surfaces and let it alone.

Wait at least a year before deciding curettage has been unsuccessful—before attempting to repeat and correct a seeming failure. It may not be a failure, for we have seen the gingivae of many teeth remain clinically inflamed for one, two, and even three years after radical subgingival curettage, and then become surprisingly healthy with no further treatment (Fig. 4A & B).

(2) *Pain in the Surrounding Tissues.* Like pain in the tooth itself, pain in the surrounding tissues is a variable from day to day, from patient to patient, and from tooth to tooth. It is greatest on the days when the diseases are most active; least during periods of quiescence. Such pain is difficult to avoid during curettage, but careful and skillful operative procedure will enable the operator to curette most pockets without resorting to surgery for access or to anesthesia for help.

Probably the most common cause of pain in the gingivae is these sore and inflamed tissues. The operator must keep the *side of the point* in contact with the tooth surface. He must also be sure, as mentioned under Instruments, that the point is not deflected by constant sharpening (Fig. 7 D). Otherwise, the edge of the deviation will be curetting the tooth, while the deflected point is lacerating the tissues.

Undue distention of the tissue wall or undue trauma with the side of the curetting instrument may also be exceedingly painful. An occasional slip and laceration is almost inevitable. Do not try to reach the bottom of the crevice at first. As the deteriorated enamel, cementum, and dentin are removed, access will be gained to the deeper areas without undue stretching and traumatizing of the soft tissues. Make use of the "ledge" which usually forms near the bottom of the pocket while curetting the more accessible areas (described above—Fig. 5 d, e, & f and Fig. 6). Let it serve as a painless "stop" for the instrument as it passes into the deeper parts, until the rest of the surface has been completely curetted, and then carefully remove the ledge as the last step in curettage.

Fig. 9. Female—45 yrs. Upper teeth extracted for terminal periodontitis complex several years before being seen by the author, March 1947. At that time, all lower teeth were markedly mobile, extremely sensitive to the slightest cooling with room temperature air, sore during mastication, and the gingivae were slightly thickened, but otherwise of comparatively normal texture and color. No calculus was found. The pathologic crevices were universally deep and the x-ray disclosed advanced alveolar resorption. The diastemas were wider before treatment than shown in the photograph, taken July 1951.

Radical subgingival curettage was performed at two week intervals until May 1948 (26 one hour sittings), every two months until June 1949, every three months until March 1950, and every three or four months to date. The teeth are firm, completely insensitive to room temperature air, comfortable during mastication, and the pathologic crevice is practically nonexistent. Interestingly, there has been some calculus formations since radical subgingival curettage, where none existed before, but it has been of the supragingival variety and does not seem to have adversely affected the favorable results.

Some operators are using novocaine quite routinely, particularly in the early sittings. We prefer to depend on careful operative procedure, which, though possibly more time-consuming, does permit our patient to leave the office and go about his normal daily routine, little disturbed from the day's procedures. It was our misfortune several years ago, to employ pontocaine as a topical anesthetic, flowing it into the crevice to be operated before curettage was started. It was a great help to the patient, but in a few weeks your author developed a marked pontocaine dermatitis which took many months to cure. He is hesitant about trying another.

After curettage, pain in the surrounding tissue is usually minimal and of temporary duration. Three or four hours after curettage, a dull throbbing fullness is common. This is transitory, usually lasting for only an hour or two. By the following day there is surprisingly little discomfort, even to rather vigorous toothbrushing. *The greater the thoroughness with which the deteriorated tooth surface is removed, the less the postoperative discomfort and the more rapid the return to normal.*

The best treatment we have found for these

gingival reactions is a *hot* hypertonic salt solution (1 tablespoonful in a glass) *held* on the affected area and repeated half-hourly. Routinely this is given the patient at the end of each sitting, with instructions to *hold*, not rinse, until it no longer feels hot; and then to repeat several times. This seems to serve as a discomfort preventive and emphasizes the manner of home treatment, though patients rarely are uncomfortable enough to bother to use it.

During the months required for a return to long-lasting health, recurrent inflammations, with hyperemia, soreness, and hemorrhage on brushing are common. If these signs are used as the criteria, not infrequently the treated gingivae actually look worse than the untreated. This worried us for a long time, until we remembered that inflammation is not only the body's reaction to an injury—it is the healing process as well, and the process of resorption and replacement of fibrous connective tissue and bone is notoriously slow. *It takes at least a year after successful treatment for the tissues to present the usually accepted normal in most moderately affected areas.* Seeming failures at the end of six months become successes at the end of two or three years, without further treatment (Fig. 4).

(3) *Psychogenic Discomfort.* In addition to the pain in the tooth and the pain in the surrounding tissues, the sound and feel of the scraping instrument as it removes the deteriorated surfaces is very distressing to some patients. They compare it to the "squeal" of a fingernail or a piece of chalk on a blackboard, and to them it is as disagreeable as the pain itself.

The sound of the curetting instrument passing over the rough tooth surfaces is distinctly audible to the operator and to others in the room; to the patient it is greatly amplified. They soon learn to detect the soundless smoothness of a truly completed surface, as compared to the "gritty," "crunchy" sound of the uncompleted, and will look askance should the operator stop without attaining it.

Little can be done to eliminate the sound, but it can be modified by slower and shorter strokes with moderate pressure. Most patients become accustomed to these sounds as treatment follows treatment, and accept it, particularly when treatment has progressed far enough that the patient himself is convinced of the benefits he has received.

The sight of blood is distressing to some people, and on occasion the hemorrhage is severe. Large clots can usually be removed on the curetting instrument and disposed of in a receptacle behind the operator. Generous use of the spray bottle or floods of warm water so dilutes the rest that it is less objectionable. Blood on the tray and on previously used instruments can be avoided by careful operative housekeeping.

Freeing the patient's mind from the dread of surgery may be difficult for the first two or three sittings, but as confidence is gained through experience, the dread decreases, especially if the operator remains cool and confident, and demonstrates his care, his thoroughness, and his consideration for the subject's discomfort. Some patients continue to talk about disliking the treatment, but rarely break an appointment, arrive on time, and show little signs of any real suffering. Were the discomfort very severe, we doubt if we would have the high percentage of patients continue treatment that do.

Patient management—everyday psychology—is a large part of the successful practice of any phase of dentistry. It is invaluable in radical subgingival curettage.

SYSTEMIC COMPLICATIONS

More and more, with each passing year, we become convinced that periodontal diseases are a factor in general health and systemic disease. We are planning to discuss this at greater length at a later date, but an outline of our beliefs is necessary at this point that we may better understand our treatment planning.

An introduction to our observations on the part periodontal diseases play in focal infection has already been published.[5] Better studies are in progress. If foci of infection are important, periodontal diseases cannot be ignored; or, if they are to be ignored, one must logically disregard chronically infected tonsillar crypts, chronic sinusitis, prostatitis, leucorrhea, etc. I find few physicians ready to go so far. I do find physicians surprised and fascinated that periodontal infections exist—that there are such chronically ulcerated and infected surfaces in the degree that they are present in the mouth. I find few dentists with any realization that the situation does exist or that it has any particular health significance. The physician depends on the dentist for the estimation of the degree of oral foci of infection; the dentist usually doesn't know it is there.

It matters little whether the harmful effects of foci of infection are caused by actual bacterial transmission through the blood stream, by the dissemination of toxic products to remote parts of the body, or whether these chronic infections are non-specific "stressors" as described by Selye. Regardless of the means, many patients improve in health after the removal of dental infections. Extraction of *all* of the patient's teeth is one way; removal of periodontal and periapical infections is another.

The practitioner of radical subgingival curettage is in an unusually favorable position to watch his results, for he sees his patient under ideal conditions at frequent intervals for a long period of time. He can question them and watch their general well-being or lack of well-being at each visit. Rarely does the physician have the opportunity to study his cases so regularly.

The following is the present status of our opinion from observation over the last ten years—not a finished study, but rather a composite of a series of impressions gained from hundreds of hours on many patients. It is subject to revision at any time as more study and observation bring newer concepts. It is a preliminary sketch from which we hope a part of the final painting will be made.

The periodontal patient carries a chronic infection, subject to exacerbations and periods of quiescence. The infectious organisms within the periodontal pocket are many and usually are not markedly pathogenic, though many of them may become so under favorable conditions. Periods of quiescence probably represent periods during which the body has gained the upper hand and the bacteria are comparatively innocuous; periods of exacerbation, times when the bacteria have become pathogenic and have excited the body's local defense mechanism—inflammation.

Inflammation is not the only defense reaction that the body possesses, however. There is also the power to develop resistance and it is probable that a quite high level of immunity against the constant inhabitants of the periodontal pocket is present most of the time. Slight absorptions of the stressor substances, the antigens, from the pocket, constantly stimulate the body's defenses against them.

Manipulation of the periodontal pocket releases additional amounts of the stressor into the tissues and the blood stream, whether during prophylaxis, conservative subgingival curettage, radical subgingival curettage, or tooth extraction. The result is a local inflammation and a systemic reaction. Even after prophylaxis, many patients complain of a "sore mouth" and others will report the systemic reactions described below. In conservative subgingival curettage, the local soreness is around several teeth. In radical subgingival curettage, it is confined to the area of the tooth operated.

In addition to local soreness and inflammation, the observing patient may notice a definite systemic reaction, approximately four hours after curettage. The most common is lassitude, which may be so mild that the patient would disregard it if not told to watch for it, or the reaction may be sufficiently severe that it approaches lethargy—an overpowering desire for rest and sleep. Occasionally, excessive curettage during the early sittings brings on decidedly uncomfortable and dangerous reactions. It has been our misfortune to see a markedly severe exacerbation of an old kidney pathology within three days following early radical subgingival curettage, with the physician, the patient, and myself convinced that we had pulled the trigger with too much curettage at one time. We have seen several severe exacerbations of gastric ulcers, one of colitis, several diabetic, several arthritic, one hives, and many headaches, "nervous attacks," and muscular and neuralgic aches and pains. Recently, ten minutes of radical subgingival curettage at the bedside of a 26 year old female with severe rheumatoid arthritis was followed by a severe reaction in the knee most actively involved, within a period of four hours, and a three degree rise in temperature with corresponding rise in pulse rate, within twenty-four hours. And hers was only a degree of periodontal involvement that we usually consider an innocuous gingivitis.

There is no scientific "proof" that the curettage and the systemic reactions are related; only a sufficient number of cases that it seems highly probable that there is a definite connection between the two. We have learned to avoid them.

Were this our only evidence, we would have to content ourselves with piling up case after case, with adequate medical histories and competent medical opinion making the decision as to the original diagnosis and the amount of improvement following treatment, and this we are attempting to do. But, there is another interesting series of observations which adds probability to the above. Too much curettage at the first sitting (or too much prophylaxis) may cause the severe reactions just mentioned, while small amounts of curettage at the first sitting rarely causes more than lassitude—a reaction we consider desirable. Two weeks later, the same amount of curettage will result in no systemic reaction, but an additional time spent or area covered in treatment (approximately twice as much) may again give

about the same amount of lassitude as the shorter sitting before. Again, on the third sitting, two weeks later, the same amount of treatment as on the second will probably give little or no reaction, but doubled will result again in the usual moderate reaction. After the third to the sixth sitting, an hour of radical subgingival curettage gives comparatively no reaction, and we assume that the result would be the same with repeated conservative subgingival curettage and prophylaxis.

The only explanation we can offer for this progressive loss of undesirable sequelae is that the body builds an immunity—develops a resistance to the stressor released during curettage. That it is some such process is further evidenced by the following.

Radical subgingival curettage confines itself to one surface of one tooth at a sitting, until all deteriorated tooth surface is removed. Thus, at the end of several sittings, only a few surfaces have been operated. Yet, the improvement in the health of the entire mouth is marked in almost every case —untreated teeth as well as treated teeth—improvement too great to be confused with the quiescent periods we have discussed. What else could have happened to the untreated teeth but a systemic reaction which increased the patient's ability to fight his own periodontal infections? Figure 3 illustrates such a case, a 39 year old female with a marked periodontitis presenting an edematous and chronically hemorrhagic gingival reaction, definite mobility of all teeth, and extreme sensitivity, who failed to follow our prescribed treatment faithfully, but who averaged about six to seven sittings a year over a five year period. The lower left bicuspids and molars, the upper left 2nd bicuspid and molars, the upper right central incisor, the upper right 2nd bicuspid, and the lower right molars have not been curetted, yet there is a marked improvement in the health of the periodontium and a disappearance of mobility and sensitivity in these, as well as in the treated teeth, though close examination reveals greater gingival health in the treated than in the untreated (upper right central untreated—upper left central, lateral and cuspid treated).

Interestingly, this immunity seems to be partly lost in from three to six months. That is, if curettage is discontinued for too long, mouth health visibly deteriorates and the patient is aware of the change. The first sitting following such a rest results in similar reactions to those encountered at the very beginning, though they are usually not as severe and the immunity evidenced by the improvement in mouth health and by the ability to stand longer sittings without systemic reaction returns rapidly after just a sitting or two. This is in line with the known sequence of events in immunology.[6]

Concomitant with the development of these immunities, the patient reports that he "feels better." With or without definitive symptoms preceding treatment, many patients volunteer this information. The patient "looks better"; his eyes are whiter and brighter; his skin and hair have more "life"; his outlook is more optimistic and cheerful; and when questioned he will report that he does not tire as early in the afternoon and that it is easier to get up in the morning. Nervous irritability decreases; habitual gastro-intestinal distress is frequently alleviated; chronic joint and muscle pains often decrease, especially in the neck and shoulder region; headaches appear less frequently and are less severe; chronic sinus infections improve; and susceptibility to colds seems to diminish. Riggs was deeply impressed by these beneficial results to his patients many years ago.[7]

ROUTINE OFFICE PROCEDURE

The following office procedure, developed over the last 12-15 years, is based on the observations cited above.

1st Sitting—10-15 minutes. Get acquainted, as much with the patient as with the patient's mouth. Obtain a brief medical history. Examine under good illumination *all* of the oral mucosa—cheeks, hard and soft palate, tongue and floor of the mouth, the faucial tonsils and the posterior wall of the pharynx. Palpate the lymph nodes in the floor of the mouth and the cervical lymph nodes. Chart cavities, missing teeth, etc., and record the degree of mobility of each tooth. Note the degree of sensitivity to room temperature air. Photographs at this time are valuable in recording one's successes and failures. Explain to the patient the long, tedious road ahead.

2nd Sitting—45 minutes. Full mouth x-rays. More complete tooth and gingival examination. 15-20 minutes of radical subgingival curettage on a tooth not too badly involved. Warn the patient about the possible local and systemic complications described above.

3rd Sitting—(2 weeks later). Ascertain the patient's local and systemic reactions to the previous sitting. If severe, do no more than at the last sitting (15-20 minutes). If not, approximately double the amount of curettage (30-40 minutes), still not on the teeth most seriously involved.

4th Sitting—(2 weeks later). Check reactions to previous visit, and repeat 3rd Sitting.

5th and Subsequent Sittings—(at 2 week intervals). Repeat (up to 1 hour) until every surface of every tooth has been completely denuded of all deteriorated enamel, dead cementum, and softened dentin.

Obviously this is only a guide, subject to wide variations to fit the individual case. A young patient, with no known systemic complications will tolerate more on the first sitting than a middle-aged person in poor health. Be especially careful if there is a known history of diabetes, rheumatic fever, cardiac or kidney involvement, or other condition

known to predispose the body to danger from additional stressors. Many patients will be unable to detect any systemic response to the first sitting. This is splendid; start curettage for the full sitting at once. Others will report decidedly unfavorable systemic reactions for many sittings; keep the sittings short and easy until they report only a mild reaction or no reaction at all.

On two patients over the years, instead of tolerating the curettage better, the reactions seemed to increase in severity after the first several sittings —a sensitivity seemed to develop, rather than increased resistance. One was a chronic sufferer from gastric ulcers, with a cancerphobia and a history of a father and an uncle dying of gastric carcinoma. Treatment was discontinued and full extraction advised. The other was a middle-aged female with a history of several hospitalizations for gastric ulcer, whose gastric symptoms improved so remarkably during radical subgingival curettage that she went on a salad "spree," eating quantities of raw vegetables with no ill effects, but whose new reactions took the form of severe pains in the chest and down the right arm three to four days following several later sittings. Treatment was discontinued by mutual agreement. This did not happen, however, until we had curetted about two-thirds of the mouth, and today, over five years later, she reports that the teeth are firm and comfortable, though I have not been able to get her in the office to see them. Neither the gastric nor the cardiac (?) symptoms have returned.

Radical subgingival curettage is not for the unintelligent, the slothful, or the indigent. If the patient is not ready and eager to make a real sacrifice of time and money, and to endure considerable discomfort for the sake of his own teeth and health, do not start. Do not minimize the difficulties to be overcome. Do not promise success in every case. Do not claim to be able to save every tooth for every patient, forever. Warn the patient that he must accept *regular* dental service for life; that he must come until every surface of every tooth has been denuded of its dead and diseased surface, and as frequently thereafter as is necessary to check and be certain that it is kept that way.

Every two weeks is the ideal. There are, however, many patients to whom this seems an impossible situation, financially. For these, once a month is better than no treatment at all, but it is not as satisfactory as the two week interval. We have cared for many on this basis (once a month) and several self-supporting clerks and stenographers now have quite healthy mouths, though not as healthy as we feel they would have had with more intensive treatment.

The treatment of one or two areas, or even three or four, and no treatment on the other teeth is not satisfactory. The treated areas improve, but not as much as when the rest of the mouth is curetted as well.

Every stroke of the scraping instrument is of value to the patient, however. Incomplete curettage will give him great improvement, both in his mouth and in general health, which is what conservative subgingival curettage has been doing for generations. If the patient decides to discontinue treatment at any time, he will have received benefits worth many times that which he has paid the periodontist.

The operator will be unable to successfully curette every surface he undertakes, the first time he tries, particularly in his early attempts, for radical subgingival curettage is an art which one learns only with long practice. In the beginning the instrument seems clumsy, hard to direct, more painful to the patient and more tiring to the operator than it will as his skill increases. The treatment is arduous, difficult, time-consuming, and seemingly expensive. When mastered, however, it becomes a fascinating hobby and completely changes the operator's outlook on dental practice. No longer must he "wet-nurse" a lot of hopelessly sick teeth, seeing them get worse with each passing year—wondering how soon "pyorrhea will get them." No longer must he trim partial dentures around abutment teeth because of swelling and soreness; he trims the tooth, instead, relieves the cause of the swollen gingivae and the soreness permanently disappears. No longer will he be troubled with recurrently sensitive necks of teeth; as the mouth returns to health, the sensitiveness disappears. No longer must he be chagrined by the patient who insists that a certain tooth aches, even though the x-ray is negative and there is no caries or deep filling in the tooth, for he will learn to detect the exact part of the tooth which is the most sensitive (usually the area of deepest penetration) and to curette this area, with the result that his patient leaves the office without his toothache—not doubting the dentist's ability as he does if he is told that nothing is wrong. No longer will he be plagued with uncontrollable and constantly recurring gingival third caries and caries at the gingival margin of proximal restorations; the area which would have turned into caries will have been removed during radical subgingival curettage, and will not become carious if all of the deteriorated tooth is removed and the entire mouth made healthy (but which almost certainly will become carious if any softened tooth is allowed to remain (Fig. 3 —uncuretted lower left bicuspid shows beginning caries; lower right first bicuspid is caries free five years after curettage). He will have his patients become almost free from new carious lesions for long periods. Calculus and materia alba will cease to form (Figs. 1, 2, 3, 8 & 9).

The untreated teeth do not seem to deteriorate periodontally while waiting their turn; they improve. We do not recall seeing an untreated tooth

become markedly worse during a long series of *regular* visits; rather, after many sittings, the teeth seem harder to the instrument than were the ones treated in the beginning, are not as sensitive, tighten though untreated, and show marked clinical improvement in the appearance of the gingivae (Fig. 3).

THE RESULTS

The results of radical subgingival curettage are surprisingly and gratifying long-lasting. We now have several hundred teeth which have not been touched in any way except for average home care, still calculus and stain free after ten years and more—teeth in mouths with a history of years of inability to "keep the tartar off their teeth." These teeth have remained firm and completely comfortable to hot, cold, sweet, and sour, despite large areas of root exposed. The gingivae remain in an excellent state of health—thin, tough, immovable and usually free from inflammation. There is almost a complete absence of a gingival trough on most (Figs. 1, 2, 8, and 9).

Even in our most successful cases, however, there is an occasional temporary period of mild edematous swelling of the gingivae, and sometimes a slight recurrence of sensitivity and mobility. The greater the degree of mouth health attained—the less the frequency and severity of these temporary set-backs. We doubt if any mouth is ever entirely free from them, but fortunately each individual attack seems to do little harm and they are self-controlled in a few days. Over a long period of time, these slight attacks are probably the cause of the deteriorated surfaces we have just removed, and reasonably frequent follow-up visits should be made that slight recurrences may be discovered and checked.

It has been our experience, after over ten years of constantly using radical subgingival curettage, that the improvement in the health of the periodontium is greater and more permanent than by any other approach to treatment we know. We have had the opportunity to watch many cases who have had from twenty to thirty years of regular and frequent prophylaxis, consisting of thorough scaling and polishing, in the mouths of a group of highly intelligent people who were much better than average in their home care. They consistently grew worse. We have seen a few almost successful cases in our own hands and in the hands of several other men as the result of conscientious conservative subgingival curettage, but none that approach the degree of health we consistently achieve with radical subgingival curettage. We have never seen a case we would accept as being as satisfactory as our own following surgical removal of the gingivae. During the last few years we have intentionally avoided using occlusal adjustment, any medication or packs, or specific instruction in home care, that the issue might not become confused. Still we believe the results to be superior to the other approaches. Superior, but not rapid. The achievement of a really healthy mouth is a slow process. It takes from one to five years after treatment before the periodontium finally takes on that hard and clean feel and appearance that signifies success. When once attained, however, health lasts and lasts.

CONCLUSION

Radical subgingival curettage is a definitely planned procedure for the elimination of the deteriorated tooth surfaces in the area of the pathologic crevice—the "foreign body" which is responsible for the chronicity of the periodontal lesion.

It is difficult, time-consuming, and arduous, but over ten years of constant use has convinced the author that it is the best approach to the treatment of periodontal diseases to date.

A detailed description of the philosophy of treatment, the technic used, the instruments favored, and the complications encountered are included in the body of the article.

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A Simplified Procedure for Fabricating a Temporary Removable Acrylic Bite Plate

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THE use of a bite plate as a temporary splint in cases of bruxism, to minimize adverse effects of tongue habits, and for other purposes when removable protection for the teeth is desired is a well-accepted procedure. A number of appliances have been utilized in the past, no one of which seems to have been generally accepted.

The appliance described here is utilitarian and esthetically non-objectionable, and the ease with which it can be prepared should recommend it to many practitioners. Only a single impression of either the upper or lower dentition is needed, and the entire bite plate can be prepared in a single simple laboratory procedure, with minimal adjustment at the time of insertion.

Normally, the bite plate for bruxism is made to fit the upper dentition, with the lower teeth interdigitating on the exposed surface of the plate. For such a purpose, an alginate impression of the upper jaw is poured in a hard stone. All deep undercut areas on the model are filled with asbestos-clay modeling compound, and the model painted with separating solution to facilitate removing the finished bite plate. The model is then placed on a pedestal beneath an hydraulic press, and a sheet of eighth-inch plastic material positioned on the model. (The material used is the same as that utilized in a number of techniques for the preparation of stabilized base plates in full denture prosthesis.) By holding an inverted heating element one inch above the plastic sheet, the material is warmed until it softens and begins to fold easily around the model. With a blunt instrument, depress the softened material into the vault area and then apply pressure with the plunger of the press. (Asbestos-clay is also used in the plunger to mold the plastic material smoothly to the model.) There should be only minimal delay between removing the heater and applying full pressure to the model.

Within two or three minutes, the plastic material is fully cooled and permanently swaged to the outline of the model. It may then be trimmed so that one-sixteenth to one-eighth inch of the plastic material projects onto the labial and buccal surfaces of the teeth. Only minimal finishing

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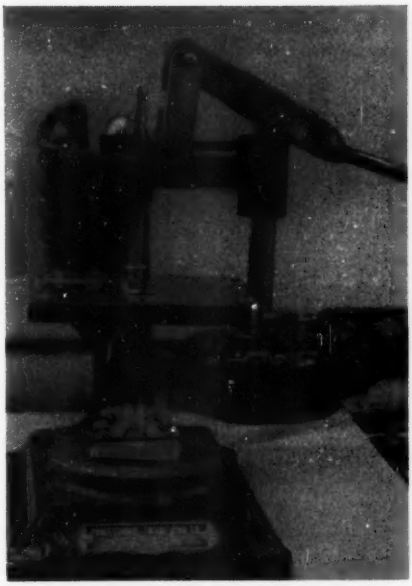

Fig. 1. Model positioned with plastic material in place. The heating element is ready to be lowered. Plunger of press is at right rear.

Fig. 2. The finished bite plate before self-curing resin is added to form the occlusal relationship with the opposing dentition.

is necessary, as the material has a smooth surface and is quite transparent, providing it has not been scorched by overheating.

At the patient's next visit, insert the appliance and check it for fit. Very little, if any, adjustment is normally required. A mix of self-curing acrylic resin is then prepared, the exposed surface of the plate painted with monomer, and a thin roll of cold-cure placed on the exposed occlusal surfaces. The added material is covered with tinfoil or cellophane to prevent occluding the undercut areas of the opposing dentition, and the patient instructed to close in centric relation, maintaining this position until the added plastic material has hardened. The appliance is then removed and any remaining finishing performed, so that free lateral movements will be possible.

For maximum stability, the palatal vault may be left completely covered, although horseshoe designs have proven quite stable and somewhat more comfortable for the patient. Other modifications, such as post-damming, may be utilized when they seem necessary.

In a number of cases of loss of vertical dimension in full denture patients, similar plates have been prepared to fit the lower denture and permit gradual increasing of the vertical opening. From time to time, increments of self-curing acrylic are added to the plate, until the desired vertical height is attained. This slow procedure seems to successfully eliminate the discomfort often noted in an abrupt change to a new vertical relationship.

Almost uniformly, patients have found no objection to the plate described here, either as to esthetics or to comfort. Its simplicity and adaptability should recommend it for more general use.

The author wishes to express his appreciation to Mr. Carl Knoettner for his assistance in establishing the laboratory procedures utilized herein.

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A Macroscopic and Microscopic Study of Instruments Designed for Root Planing*

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ROOT planing is an instrumentation used in the removal of calcareous deposits from the clinical crowns of teeth, rendering the tooth surfaces smooth —from the bottom of the pocket to the tip of the crown. If used as a preventive measure or in routine maintenance of a mouth, it may be termed "prophylactic root planing." If it is carried out as a treatment procedure, we term it "therapeutic root planing." Root planing is necessary to the success of almost all periodontal treatment, being part of the procedure of subgingival curettage, gingivectomy of any type and reattachment attempts by direct or by flap approach.

A successful root planing, whether used in prophylactic or treatment procedures, requires the skillful use of instruments carefully adapted to the needs of the operation. The extent and direction of the application of this well designed armamentarium will be guided by the operator's intimate knowledge of the tissues involved, including their topography, histology and physiologic responses.

It is important to know that calculus always extends to the bottom of the pocket. This fact is clearly demonstrated by microscopic study of human autopsy and biopsy specimens (Figs. 1 & 2). The space between the calculus and the soft tissue wall of the pocket, seen in the microscopic specimens, is an artifact caused by shrinkage during preparation for microscopic observation. Some investigators have described a "subcalcular space" between the apical end of the calculus and the tissue attachment.[1] This observation was based entirely upon a clinical study carried out on extracted teeth and the investigator overlooked a most important fact. The apparent "subcalcular space" was an area occupied by the epithelial attachment, the average length of which is about 1.5 mm.[2] Recognition of this fact was made many years ago[3] and has been more recently confirmed.[4, 5]

We should also know that the deepest extension of calculus is not as calcified or as hard as the rest of the mass. It consists mainly of shed epithelial cells, leukocytes that have migrated through the pocket epithelium, bacteria and fungi, mainly of filamentous types such as leptothrix and actinomyces. Such material is subject to shrinkage, just as the gingival tissue is. It is, therefore, presumptive that in life, calculus fills the space between the root surface and the soft tissue wall of the pocket.

The removal of calculus should cause the least amount of injury to the soft and hard tissues forming the pocket. Since this procedure may be repeated periodically, the greatest care should be exercised to remove a minimal amount of tooth structure. The deliberate removal of extensive amounts of tooth structure sometimes advocated[6, 7] cannot be justified.

To obtain a good result in an operation that involves root planing, the root surfaces must be completely divested of all calcareous deposits and made perfectly smooth. Root planing, perfectly performed, will greatly increase the likelihood of a successful result from treatment. Since the operation is painstaking, requires skill and is tedious, it is well to consider thoughtfully the design of the instruments to be used. There are three principles that govern the design of instruments to be used for root planing:

1. They should be mechanically designed to give the operator the greatest opportunity to use his dexterity and to

*From the Colorado Dental Foundation.

Fig. 1-A. Interproximal space between two bicuspids (human autopsy specimen) AC—Alveolar crest. CT—Transseptal connective tissue. P—Interdental papilla. BP—Bottom of pockets. C—Calculus. EA—Epithelial attachment.

B—Higher magnification of bottom of pocket (BP), with the calculus (C) filling out the entire pocket space. PE—Pocket epithelium, broken in some areas. E—Epithelium shed and clinging to surface of calculus. EA—Epithelial attachment. The subepithelial connective tissue shows severe inflammatory condition.

satisfy his application of skilled knowledge.

2. The working tips of the instruments should be specifically designed for the efficiency of instrumentation.

3. They should be designed with this biologic principle in mind, namely, to cause as little damage as possible to both the gingival tissues and the tooth structures.

1. GENERAL DESIGN

The general design of an instrument, regardless of the kind of working tip, must be adapted for comfort to the operator. A thin-handled instrument held firmly for long periods of time causes cramping of the hand and fatigue. Fatigue lessens efficiency! Therefore, from this utilitarian point of view, the instruments should have thick handles (Fig. 3). On the average, the handle at the area of the finger grip should be 8 or 9 mm. thick. A roughened, round or octagonal grip should be provided for a good finger-hold. The handle should be designed to counterbalance the working tip.

The working tip of an instrument should not be farther than 1½ inches (35 to 40 mm.) from the grip. If this distance is too short, the action of the instrument will be limited. If it is too long, it becomes un-

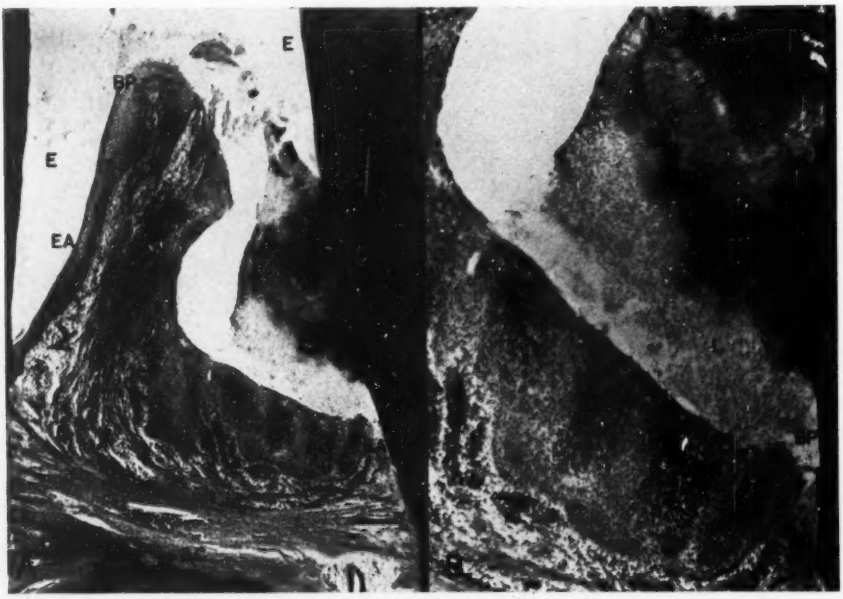

Fig. 2-A. Interproximal space between a second and third molar (left). The bottom of the pocket on the third molar is on the enamel (BP_1), whereas it is on the cementum (BP) of the second molar. E—Enamel, lost in decalcification. EA—Epithelial attachment. CEJ—Cemento-enamel junction. C—Calculus. AC—Alveolar crest.

B—Higher magnification of the bottom of pocket (BP). Calculus (C) separated from the pocket epithelium (PE) by leukocytes (L), which have migrated through the pocket epithelium from the highly inflamed connective tissue.

balanced. The illustration in Figure 3 shows the proper proportions.

Another important specification of design is that the working tip of an instrument should be centered in the long axis of the handle (Fig. 4A) and certainly within the projection of the long axis. An instrument with its working tip off center (Fig. 4B) has to be held more firmly, which will cause a cramping of the hand muscles. Such a defect in an instrument, coupled with a thin handle, multiplies its disadvantage (Fig. 4C). The working tip can be properly aligned with the long axis of the handle by correct contra-angle construction of the instrument.

2. DESIGNS FOR SPECIFIC NEEDS

The functional purpose of an instrument should be well understood. Some instruments are more efficient in removing bulky calcified deposits, but are not made to reach to the bottom of the pocket. Others are made so that their working tips can be carried below the apical end of the calculus at the bottom of the pocket without causing undue damage to attachment tissues.

The names given to instruments usually describe the shape and design of their working tips. From a number of instruments in present use, chisels, hoes, sickles, files and curettes were selected for the purpose of this study. Enlarged illustrations of these instruments are shown in Figures 5, 6, 7, 8, 9. The differences in design are clearly portrayed.

There is considerable variance in the size of working tips. Measurements were made where the shank joins the working tip and of the working tip itself at its different diameters, as shown in Figure 10.

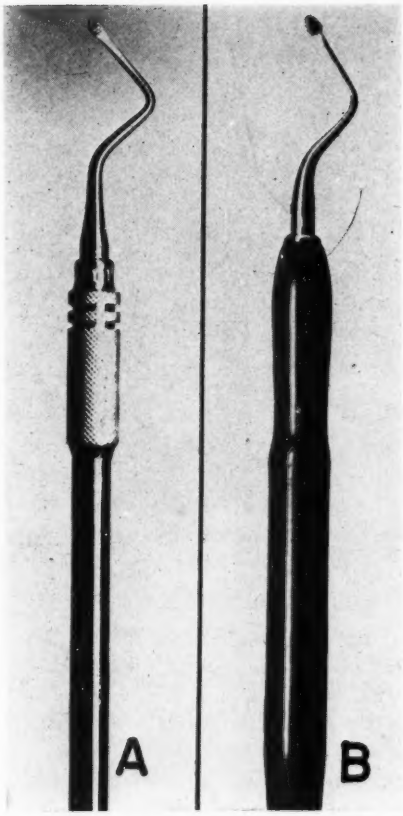

Fig. 3. A—Hollow metal handle—Correct design. B—Plastic handle available in different colors to make instruments easily recognizable. The instrument in the metal handle can be autoclaved, whereas the plastic handle may only be put in cold sterilization, but the tips may be autoclaved.

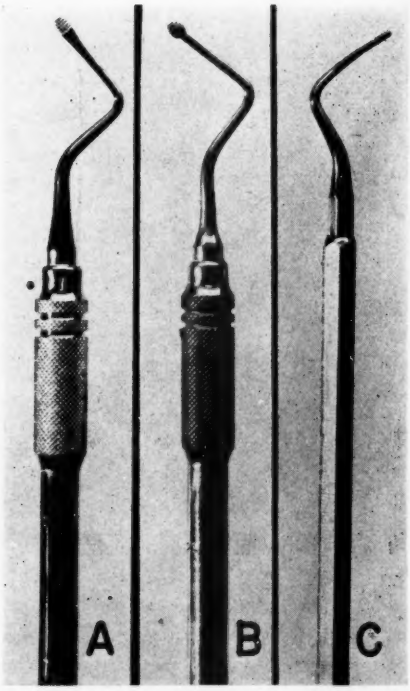

Fig. 4. A—The working tip of an instrument must be in the long axis of the handle. B—An instrument with its working tip off center is poorly balanced; produces fatigue and inaccuracy in work. C—An instrument with its working tip off center, coupled with the use of a thin handle violates all rules of good design.

In general, each of the five types of instruments is made for a specific use. The chisel, hoe and sickle are designed for the removal of heavy calculus, while files and curettes are intended for the finer and final planing of the root surface to the bottom of the pocket.

The chisel (Fig. 5) is most universally used in the lower incisor region. It is used with a push stroke in a labiolingual direction and is particularly efficient in breaking up masses of supragingival calculus, especially when the deposits on the lingual are confluent with those situated interproximally. Many chisels have very sharp corners which may gouge the tooth surface and traumatize the tissues. These corners may be rounded without affecting the efficacy of the instrument. The design of the chisel has been refined and modified by some operators[8] and is used for the very finest root planing.

Hoe-shaped instruments (Figs. 6 & 11) are intended for the removal of easily accessible calculus. They should be used subgingivally only when the gingiva is flabby and is easily displaced. The operator should avoid pushing such instruments to the bot-

Fig. 5. Conventional type chisel scaler—Has sometimes been termed "push scaler."

Fig. 7. Working tip of a sickle with four working edges.

tom of the pocket, as they are bulky in design as seen by the measurements in Figure 10.

Sickle-shaped instruments (Figs. 7 & 12) have a 90° angle on all four cutting edges and are extremely thin at the working tip, sometimes as fine as .20 mm. They may be used in a push or a pull stroke. A large, hooked sickle is helpful when used on the lingual surface of lower incisors, an area difficult to reach with shorter instruments. Double contra-angled sickles

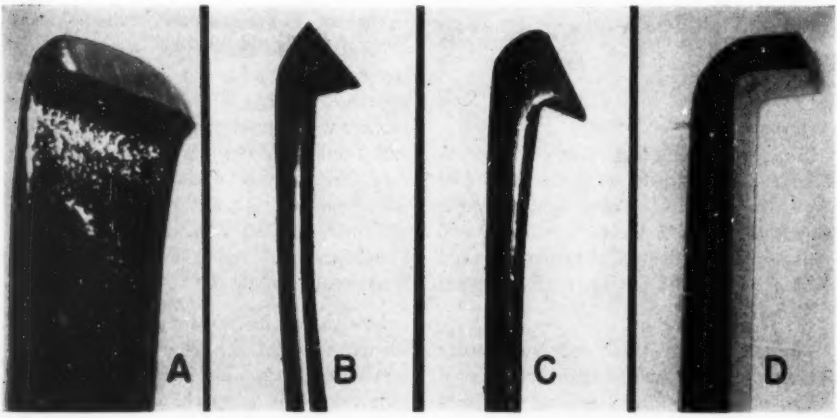

Fig. 6. Various designs of hoes. A—Front view of hoe, with corners rounded. B—Same hoe in lateral view. C—Hoe with acute rake angle—would cause gouging of root surface. D—Sharp cornered, right angle hoe with thick tip.

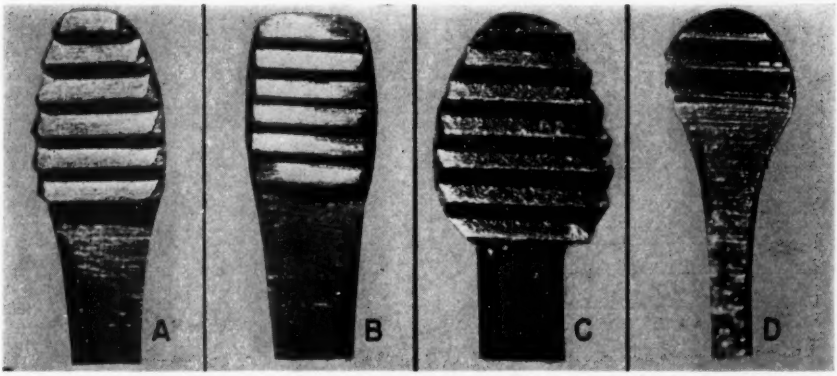

Fig. 8. Various designs of files. A—Oval shaped—blades cut at 105° angle—corners rounded. Neck wide, preventing breakage. B—Narrow file—blades cut at 90° angle, corners rounded. Neck wide. C—Leaf-shaped file with blades cut at 130° angle—corners sharp. Neck narrow (will break at this point). D—Small file with blades cut at 105° angle, corners sharp. Neck wide.

(Fig. 12) are well adapted for interproximal use in the bicuspid and molar areas.

Files (Figs, 8 & 13) may be considered as the cutting blades of four to six hoes combined, but are much thinner instruments. These instruments are used for finer planing of the root surfaces and if properly designed, reach the bottom of the pocket without injuring the attachment.

Curettes (Figs. 9 & 14) are spoon-shaped and are similar to spoon excavators used in operative dentistry. The curette has two functions. As its name implies, it is used to remove the soft tissue wall of the pocket. It is also used as a root planer. Frequently, both functions are simultaneously performed. The term "curettage," however, should be reserved for the removal of soft tissues. Although the curette may be measured at both spoon dimensions, the instrument is usually used at neither. Curettes are used at angles from 25° to 85° which makes comparison with other instruments difficult. When used at an acute 25° angle, it is the one instrument that can reach below the calculus with the least amount of injury to the tissues at the bottom of the pocket. At this angle, however, it is not as efficient as some other instruments.

3. BIOLOGIC CONSIDERATIONS: WITH REGARD TO SOFT TISSUES

All design and size specifications are im-

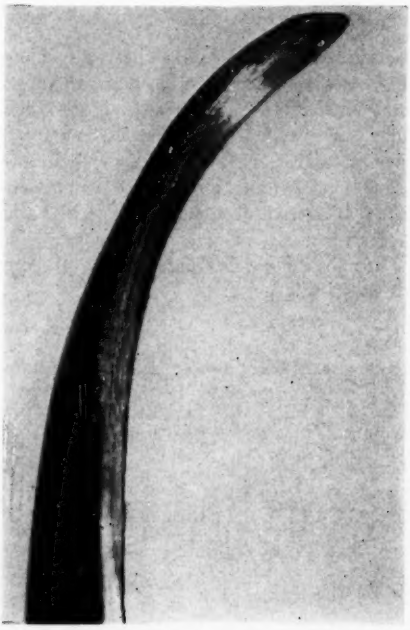

Fig. 9. Working tip of a curette—half round with two sharp edges.

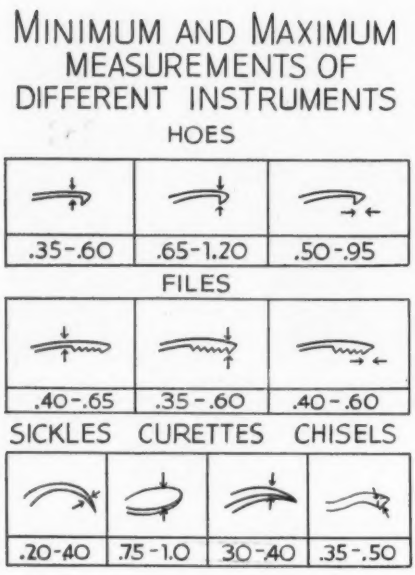

Fig. 10. Chart—Giving measurements of the working ends of different instruments.

portant when considering the biologic requirements of successful root planing. The instrument must be comfortable to the operator's hand. It should not cause cramping or fatigue. It must be sharp, well balanced and specifically designed for its intended job. No substitution should be made for an instrument of choice. For example, a hoe should not be used for fine planing

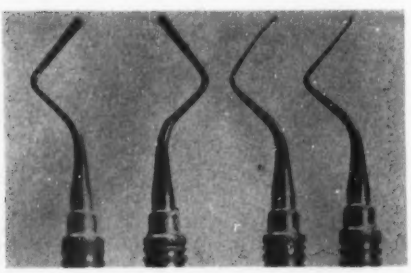

Fig. 11. Hoes—to reach four surfaces of any tooth. The design of the tip is shown in cross-section in Figure 17B.

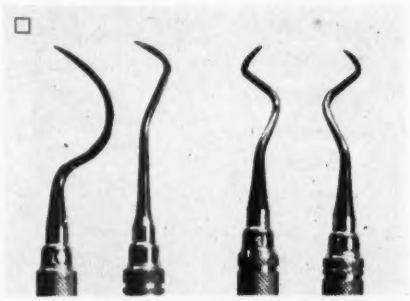

Fig. 12. Four sickle-shaped instruments. Cross-section of the tip is shown in the corner diagram. The long, hooked sickle is helpful on the lingual of lower incisors. The two double contra-angle sickles are for interproximal areas between bicuspids and molars. All these sickles may be used as push and pull instruments.

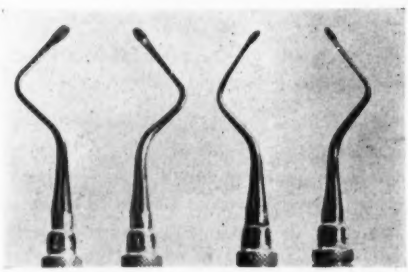

Fig. 13. Four files, to reach any surface of the teeth. The files are constructed according to Figure 18B.

at the bottom of a pocket. Neither should a curette be used for the removal of heavy calculus where the hoe may be employed to a greater advantage and with more efficiency and speed.

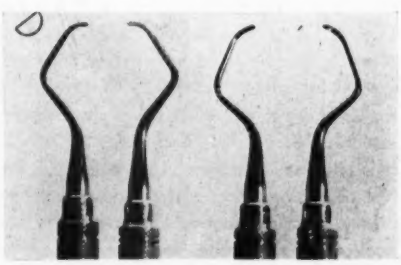

Fig. 14. Four curettes—universal in design. Two for mesial surfaces—two for distal surfaces.

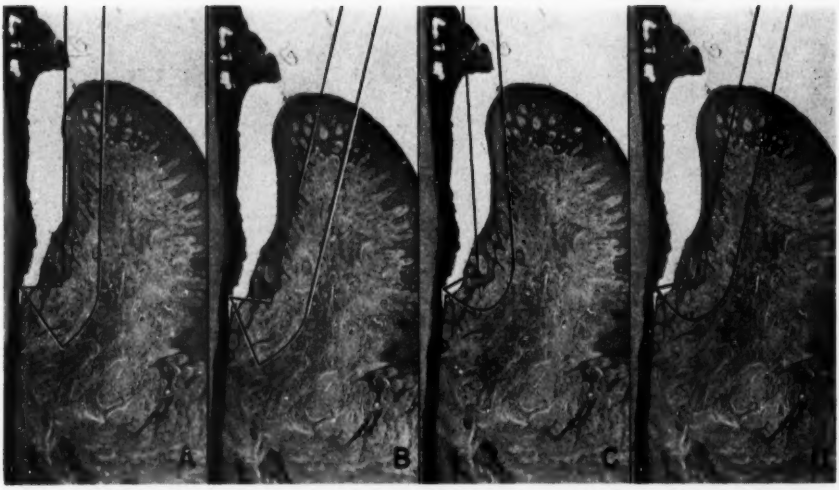

Fig. 15. Hoe—superimposed upon photomicrograph of same magnification, showing pocket with supragingival and subgingival calculus. The calculus extends to the bottom of the pocket.

A—Old type hoe with 90° rake angle and with its shank parallel to the root surface. Long heel of the instrument extends into the tissues.

B—The same hoe, with its shank about 15° to 20° from the root surface. The cutting blade of the hoe forms an open (obtuse) angle with the root surface, making it more likely to cut the surface.

C—New design of hoe, with shank parallel to tooth. Rake angle of instrument 105° (negative), forming with tooth an acute angle. This makes instrument less efficient, but safe for planing the root surface.

D—Shank of instrument 15° to 20° from tooth surface—cutting blade at desired 90° angle to tooth.

In studying the relation of the instrument to the pocket, a technique used and described by Bodecker[9] was employed. This method was used by Waerhaug in a more recent study.[10] Enlargements of instruments superimposed on photomicrographs of the same magnification make correct visualization of the relation of the instrument to both the soft and the hard tissues. In Figure 15A, a conventional type hoe may be seen, with its shank parallel to the tooth surface. Used in this way, the working tip is placed at right angles to the tooth surface. This makes the instrument very effective in the removal of heavy and hard deposits. However, it is almost impossible to keep the shank in this position, except in a cumbersome two point contact technique. If the instrument is moved only 10 to 20 degrees from this position, the tip will form an angle of more than 90° to the tooth surface and can gouge the root. The long heel of the instrument also penetrates deeply

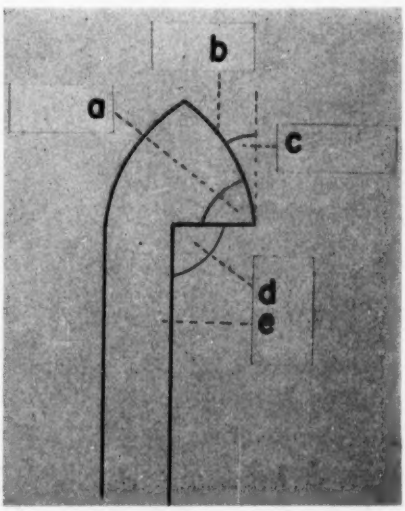

Fig. 16. Diagram illustrating nomenclature of different parts of an instrument and the angles of construction. The rake angle is positive if it is less than 90°, and negative if it is more than 90°. (a) Lip angle. (b) Heel. (c) Clearance angle. (d) Rake angle. (e) Shank.

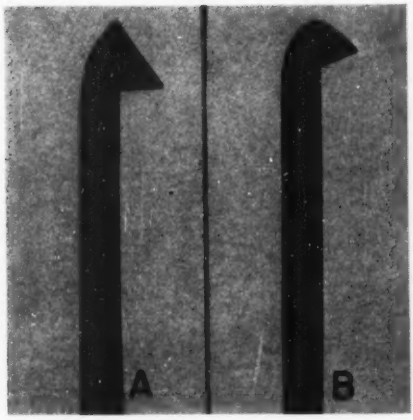

Fig. 17. Cross-section of two hoes. A—Old construction with 90° rake angle and long heel. B—New construction with 105° rake angle (negative) and short heel.

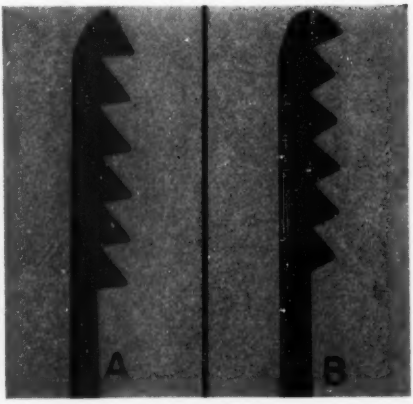

Fig. 18. Cross-section of two files. A—Old construction with right angle cuts of blades. B—New construction with 105° cut of blades, shorter heel.

into the tissues or displaces them excessively (For nomenclature of the different parts and angles of an instrument, See Fig. 16). These disadvantages compelled us to redesign the instrument. The 90° rake angle (Fig. 17A) was changed to a 105° negative rake angle (Fig. 17B) permitting a reduction in the length of the heel, which was further reduced by rounding it off. If such an instrument is placed with the shank parallel to the tooth, the active angle becomes less than 90° (Fig. 15C), which

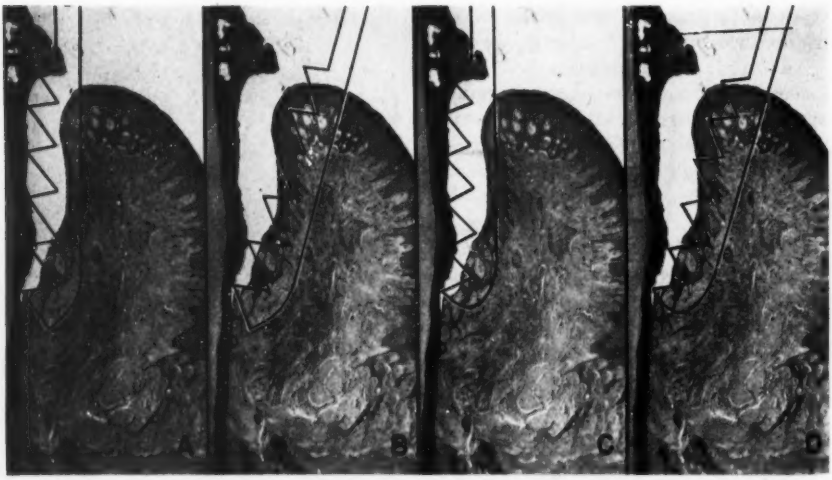

Fig. 19. Files superimposed upon microscopic specimen (same magnification). A—Old file with shank parallel. Blades at right angles to tooth—long heel. B—Same instrument with its shank at 15° to 20° angle to the tooth. Blades form obtuse angle with tooth surface. C—New design of file parallel to root surface. Blades at an acute angle to tooth—short heel. D—Same instrument at 15° to 20° angle with blades at right angles to the tooth—short heel.

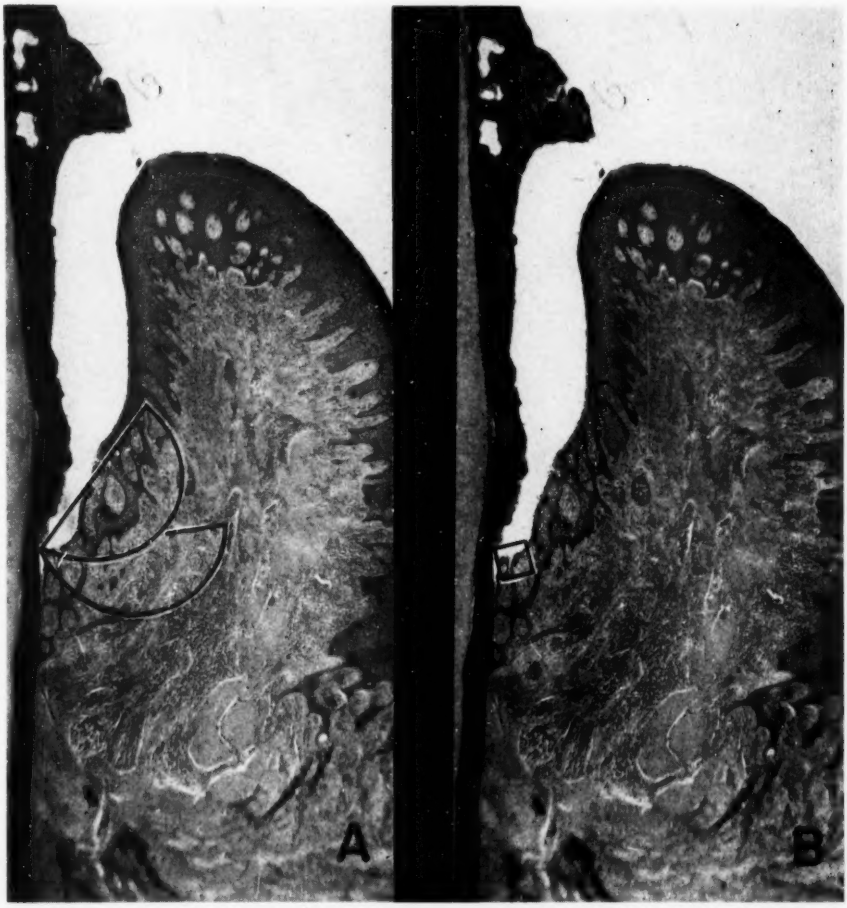

Fig. 20-A. Cross-section of curette in pocket in two different positions—at a 35° angle and at an 85° angle. At a 35° angle, it is safe for soft tissue, but ineffective in removing hard, bulky deposits. At an 85° angle, it is effective in removing calculus, but also curettes tissues.
B—Cross-section of tip of sickle in pocket. Smallest of all instruments. May be used push or pull.

may reduce its efficiency, but will also lessen the possibility of injuring the root surface. If the angle of the shank to the tooth is changed by 10 to 20 degrees, the active rake angle will become 90° and complete efficiency will again be restored (Fig. 15D). In addition, the heel of the instrument is shorter and is less likely to injure the soft tissues of the pocket. (This problem of the angle of the face of the instrument to the shank and the working tip to the tooth has been discussed by Stillman and McCall[11] and more recently by S. C. Miller.[12])

Figure 18A shows a cross-section of an old file with cutting blades at right angles to the shank and with quite a long heel. This instrument was redesigned according to the principles used with the hoe. The rake angle was changed from 90° to 105° (Fig. 18B). As a result, it is easier to keep the instrument sharp. While a cutting

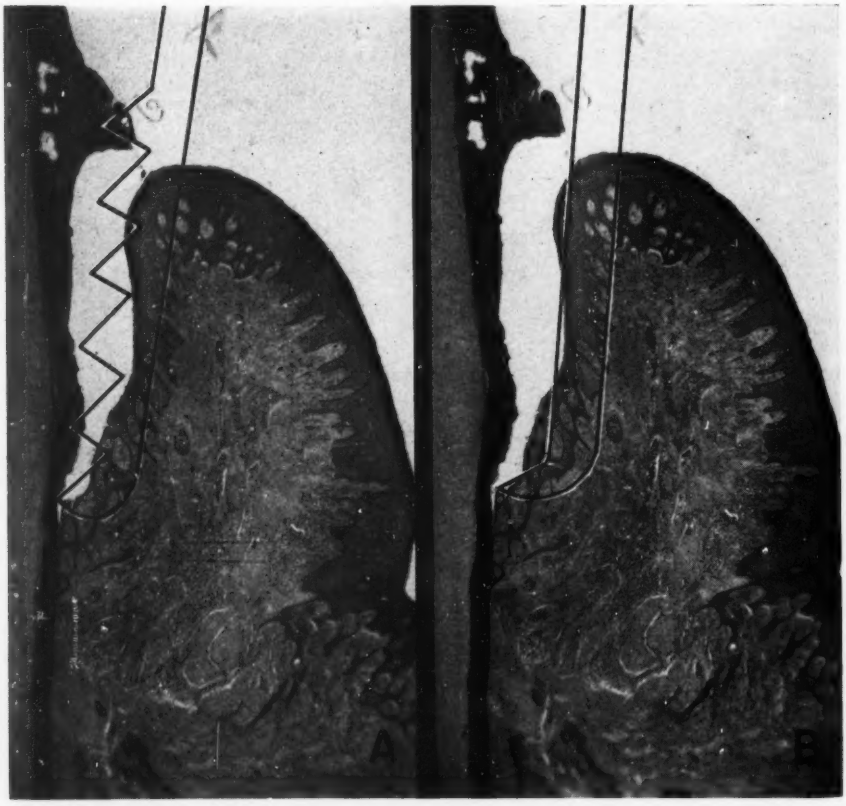

Fig. 21-A. Experimental file.
B—Experimental hoe. Each superimposed upon a photomicrograph of the same magnification. The rake angle of the cutting blade is about 120° to 130° (negative) and in its relation to the tooth, the angle is then too acute for effective planing with a pull stroke.

blade with a narrow lip angle may be initially sharper, it becomes dull more quickly than does the blade with a wider lip angle.

The old and the redesigned files are shown in the gingival pockets in Figure 19. When the old file (Fig. 19A) is held parallel to the tooth its cutting blades are at right angles to the root surface. However, the heel is too long and would excessively displace the soft tissues. If the shank to tooth angle is varied by 10 to 20 degrees (Fig. 19B), the blades would gouge the root-surface. With the improved design (Fig. 19C), the danger of gouging is eliminated and soft tissue displacement by the heel is reduced.

As has been previously stated, curettes may be used for soft tissue curettage and for root planing, but not for the removal of heavy deposits. Used only as a root planer, the curette should be used with a push stroke at an acute angle of not more than 25°. Used in this manner, the tissue is not affected. If the curette is used with a pull stroke, the angle should not be increased beyond 45° and the side of the instrument away from the tooth should be

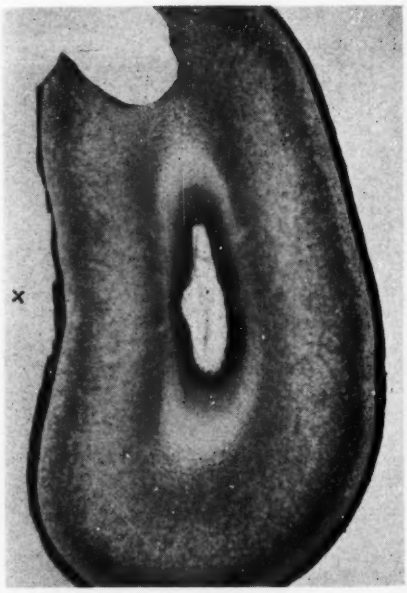

Fig. 22. Root surface (x) planed by hoe with sharp corners—cementum has been gouged.

Fig. 23. Root surface (x) planed by file with rounded corners.

rounded to insure against tissue encroachment. Figure 20A shows the curette at a 35° angle for planing and at an 85° angle for curettage. The action of the curette has been discussed greatly in the literature, more recently by L. Hirschfeld.[13]

Figure 20B shows the tip of the sickle in a pocket. It is so well adapted as to make it seem the instrument of choice for reaching the bottom of the pocket. This is not so. In approaching the tooth, the sickle must be placed laterally to it and in this manner, there is the danger of piercing the surrounding tissues or of tearing the attachment. Only when used by a skilled operator and under special conditions, should such a procedure be attempted.

The sickle may be used in either a push or a pull stroke. In a pull stroke, the instrument is placed with its inner cutting edge at an 80° angle to the tooth. The angle of clearance is then about 10°. If the cutting angle is increased, the clearance angle becomes too small because the instrument is square at its tip. We then incur the danger of the instrument slipping off the tooth surface. Whenever a push stroke is used, the outer edge of the instrument is employed. Extreme care should be exercised in the push stroke so that neither the instrument nor a mobilized piece of calculus is forced into the soft tissues. Very short strokes should be used, and the instrument should be held in a firm and well-balanced grip to prevent slipping. Only an extremely sharp instrument may be used in a push technique.

An experimental hoe and file were constructed with a negative rake angle of 120°-130° (Fig. 21A & B). This made it possible to use the instrument with its cutting edges at an angle of 40° to 50° to the tooth surface. Since the more acute angle reduces the effectiveness of the instrument in the pull stroke and since these instruments are not designed for a push stroke, the conclusion was that these instruments are limited in usage, making them impractical.

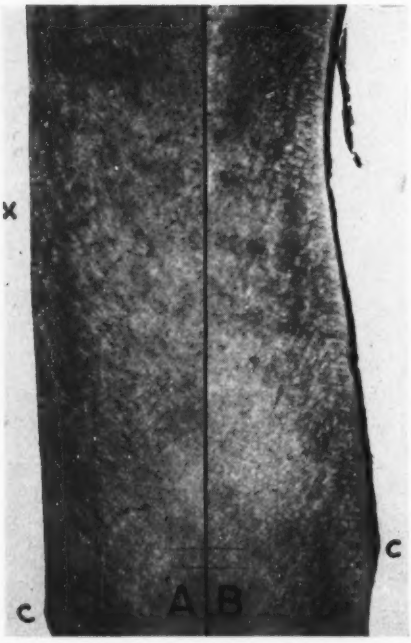

Fig. 24. A—Entire cementum removed from root surface (x) planed by hoe. This is a longitudinal section and the entire cementum is missing from the cemento-enamel junction (c). B—Other side of same tooth, showing cementum.

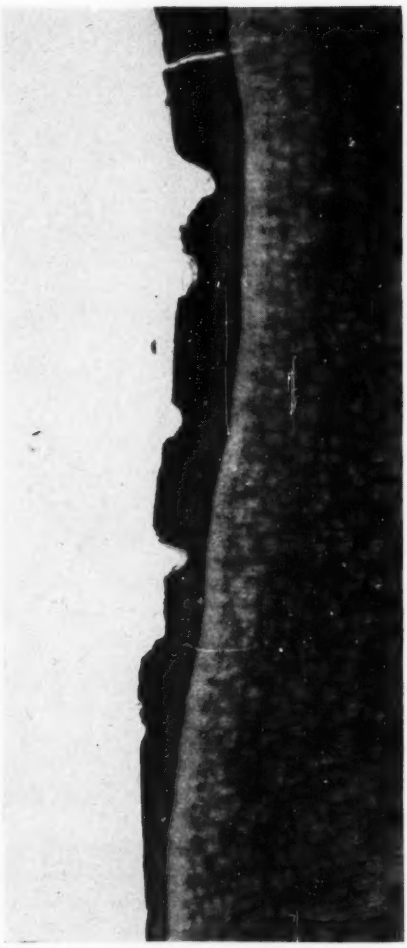

Fig. 25. Gouging of cementum by improperly designed instrument, where tip of sickle cut into root surface.

BIOLOGIC CONSIDERATIONS: WITH REGARD TO TOOTH STRUCTURES

The tooth surface should not be injured by instrumentation. Crude, excessive or violent measures cannot be justified, regardless of the body's ability to repair and compensate. With these biologic principles in mind, we should always be certain that instruments are sharp. Since dull instruments must be used with great pressure, there is the hazard of injuring tooth surfaces, or of the instrument slipping from the tooth and injuring the soft tissues. The careful operator can only view with alarm the effects caused by injudicious instrumentation.

To study the effects of instrumentation on root surfaces, 25 extracted teeth were used. The teeth were undamaged in removal and had no obvious carious lesions. Either the mesial or distal surface of the tooth was used and the opposite surface was left untouched for microscopic comparison. The effects to the root surface by use of hoes, sickles, files and curettes of different designs were tested. Each instrument was used as intended and in turn until the tooth surface was planed to the point that it was clinically smooth. This involved a varying number of strokes, depending upon the type of instrument used, the

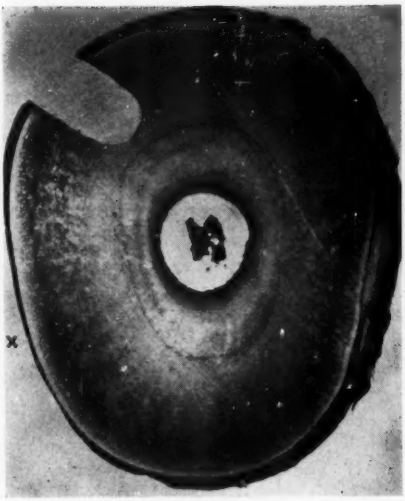

Fig. 26. Root surface (x) planed by curette.

amount of calculus to be removed, and the roughness of the tooth surface.

The following observations were made:

1. Instruments with sharp corners, regardless of type, do more damage to tooth surface than those with rounded corners. Figures 6A, 8A, 8B show instruments with rounded corners, while Figures 6D, 8C, and 8D show instruments with sharp corners. We can see (Fig. 22) the effect upon the root surface of a tooth planed with an instrument with sharp corners. It will be noted that in one area, the cementum is almost completely removed and the surface is gouged. In contrast to this, where a sharp file with properly rounded corners was used, it can be seen (Fig. 23) that no gouging or excessive removal of tooth structure took place.

2. Dull instruments which require excessive pressure in use can cause undue damage, similar to that seen in Figure 22.

3. It is possible to over-use an instrument, as is shown in Figure 24. The root surface of this molar (A) was extensively planed with a hoe to a point that it seemed smooth. We can see that the cementum is completely removed. The opposite side of the same root, which was untouched (B) offers graphic comparison. It is obvious, therefore, that while the hoe is well suited for removing large deposits of calculus, it should not be used for fine planing.

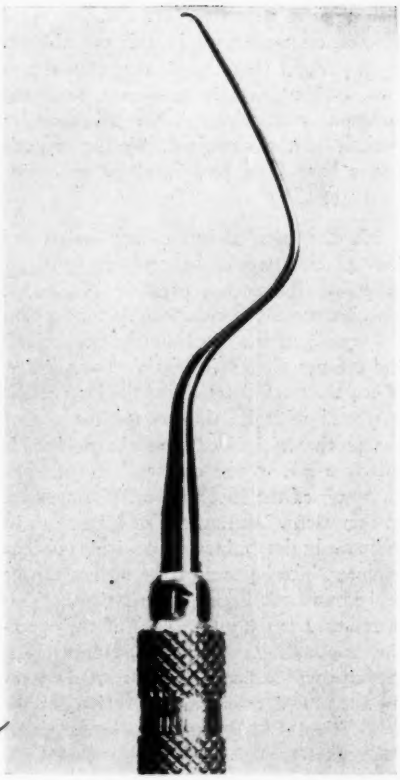

Fig. 27. Pocket explorer. The "eye" of operator, below the margin of the gingiva.

4. Whenever instruments are used, other than with the purpose for which they were intended, or are used at improper angles, there is always danger of causing injury. In Figure 25, the damage done by a sickle can be seen. The tip of the sickle was applied to the tooth at an improper angle. Note the resultant saw-tooth outline of the cementum where the instrument has been used.

5. Figure 26 shows the result of root

planing with a curette. Five different types of curettes were used in this experiment. It was found that the damage caused was minimal, but that in each case, some cementum was removed. In all cases, a smooth surface resulted. Similar experiments have been performed by other investigators.[12, 14]

No discussion of instrument design and root planing would be complete without including the pocket explorer (Fig. 27). This instrument is indispensible for making a diagnosis of the depth of the pocket and the texture character of the root surface. When the small, bent tip of the instrument is placed with its side to the surface of the tooth and guided into the pocket, it can transmit to the operator's fingers the character of the root surface. The presence of accretions, indentations or ledges can be more easily determined than with a straight explorer. The bottom of the pocket can be probed without injury to soft tissues. This instrument is truly the "eye" of the operator, below the margin of the gingiva. The explorer will indicate to the careful operator the proper extent and direction for the application of his instruments in the gingival pocket.

SUMMARY AND CONCLUSIONS

Instruments used in root planing should be designed with the following considerations in mind:

1. They should be generally well designed to give the operator the greatest opportunity to use his dexterity and to satisfy his application of skilled knowledge.

Mechanically well designed:

A. A well balanced handle

B. A thick, roughened grip

C. A working tip centered with the long axis of the shank

D. Proper contra-angle construction

2. The instruments should be specifically designed to efficiently accomplish a specific purpose.

Chisels, hoes, sickles, files and curettes, as types of various working tips, were examined and experimentally used in this study. Each instrument was determined to have a specific purpose. The manner in which an instrument is to be used is determined by the thickness, shape and angle of its working tip.

3. The instruments should be designed with the biologic principle in mind—to cause as little damage as possible to the gingival tissues and to tooth structure. In order to satisfy this requirement, the following conclusions are drawn:

A. Only sharp instruments should be used.

B. The proper angle of working tip to tooth should be known and used.

C. An instrument should be used for the specific purpose and in the specific manner for which the working tip was designed.

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Sharpening Periodontal Instruments*

by CALVIN L. FOSS, D.D.S., *San Diego, California,* AND THOMAS R. ORBAN,† *Chicago, Ill.*

IT is essential to repeat the advice of G. V. Black—"Nothing in the technical procedure of dental practice is more important than the care of the cutting edges of the instruments. No man has yet become a good and efficient dentist until after he has learned to keep his cutting instruments sharp. The student who cannot, or will not learn this should abandon the study of dentistry."

The need for an effective procedure for maintaining sharp instruments is evident. As to maintenance procedures, there are two logical approaches. Instruments may be sent to a qualified person to be sharpened, either back to the factory or to a special sharpening company. This means that several sets must be in circulation all the time! On the other hand, one may sharpen his own instruments or train his office personnel to do it.

Nearly all types of periodontal instruments may be relatively easily sharpened. It is essential that instruments be made of good carbon steel. Stainless steel will not sharpen easily, nor will it hold a good edge. In sharpening periodontal instruments, one has to be familiar with the construction of the instrument to keep from damaging it in the sharpening process.

*From the Colorado Dental Foundation.

†Dental Student, Loyola University.

EQUIPMENT NEEDED

For sharpening, one has to reserve a space in the office, such as a corner of the laboratory bench where one can sit down and utilize free moments.

A good, diffused light which has some type of shade to protect the eyes from direct glare, is essential, a sewing machine light being an excellent example (Fig. 1 & 2). A magnifying glass arrangement with the light built in, as used by some in laboratory procedures, is also a good set-up (Fig. 3).

For best results, a lens with magnification of 5X to 10X should be used. Stronger lenses develop distortion in critical focusing, but lenses up to 30X may be used for examination of the instrument only. A dissecting microscope (Fig. 1) is excellent for both sharpening and examination, but the cost is excessive unless other uses are found for this instrument. A single lens arrangement as seen in Figure 2 can be easily arranged and is quite satisfactory, or a watchmaker's eyepiece may be used. The latter, however, is tiring to the eye and should be used only for short periods of time.

A notched instrument rest of metal (Figs. 1 & 2) or of wood (Fig. 3) has to be made and fastened to the work bench by

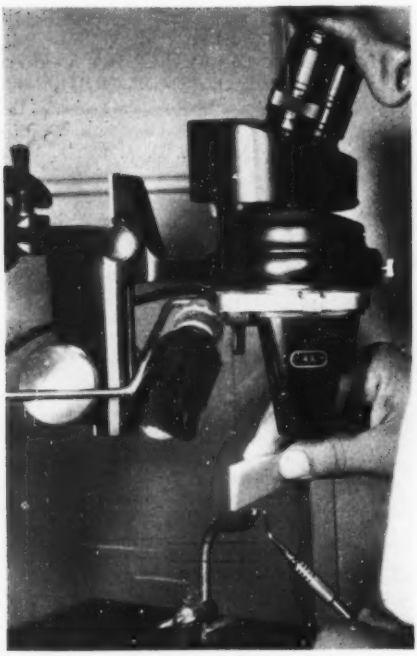


Fig. 1. Dissecting microscope, sewing machine light and notched instrument rest are needed for observation and sharpening of a file.

Fig. 2. Single magnifying lens (5X) mounted in combination with sewing machine light. Notched instrument rest.

Fig. 3. Wooden instrument rest mounted in focus of a magnifying lens with built-in light source.

a vise to give a good support to the instrument and placed so that the instrument is in the focal spot of the magnifying lens.

A good assortment of mounted and unmounted stones are essential. These should include mounted ruby stones of various sizes Figure 4 (a), an arkansas (b) or fine india wedge-shaped slip stone, fine india triangular stones and some truing stones (c). The truing stone is needed for occasional shaping of the triangular stones to fit the proper degree of the instruments' rake angles. Silicon carbide paper, grit 120 D for shaping the slip stones is needed.

A small, home-workshop type of hand motor unit, possibly with a pulley extension to accommodate several attachments (Fig. 5) is desirable for using mounted stones and discs, shaped stones, or felt wheels.

Most manufacturers sharpen the new as well as used instruments free-hand. This is quite easy to do if one understands the basic principles in the design of the cutting edge of the instrument. This knowledge requires examination of the instruments under magnification and practice in being able to cut the blades of the instruments in the proper angle. It is possible to make a

Fig. 4. Assortment of stones used in sharpening periodontal instruments. (a) Ruby stones; (b) Arkansas slipstone; (c) Fine india stones of different shapes, and truing stones.

jig device to support the sharpening hand stones or the instrument, or both, so that the stone will be held in its proper relation to the instrument throughout the sharpening stroke.

CONSIDERATION OF INSTRUMENT DESIGN

To understand the sharpening operation, a brief discussion of instrument design is necessary. It seems appropriate to employ a few terms for the instrument industry to obtain specific points of reference in describing the sharpening of instruments.

The *rake angle* is the angle formed by the working blade and the shank (Fig. 6). The *clearance angle* is formed by the *heel* of the blade and the surface against which the instrument works. The *lip angle* is formed by the surface of the heel and the working surface of the blade. This nomenclature for describing periodontal instruments has been used by S. Charles Miller in his Textbook of Periodontology. It was suggested that the ideal rake angle should be about 99°. However, because of the

Fig. 5. Motor with pulley extension. Felt wheel, chrome rouge.

operator's inability to hold the instrument in the same position to the tooth in every stroke, one can, for all practical purposes disregard 5°, plus or minus. The efficiency of the cutting edge diminishes as the rake angle becomes more obtuse than 90°. However, this condition may improve the resistance to dulling of the cutting edge. A rake angle of less than 90° will not function smoothly on the surface of the cementum as it catches and tends to gouge the root surface. A rake angle of about 100°, plus or minus 5° seems to be very usable, keeping in mind the changing relation between the cutting edge and tooth

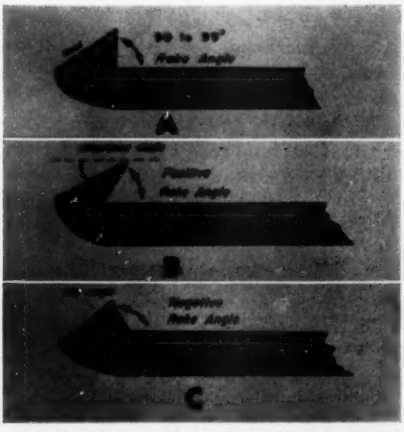
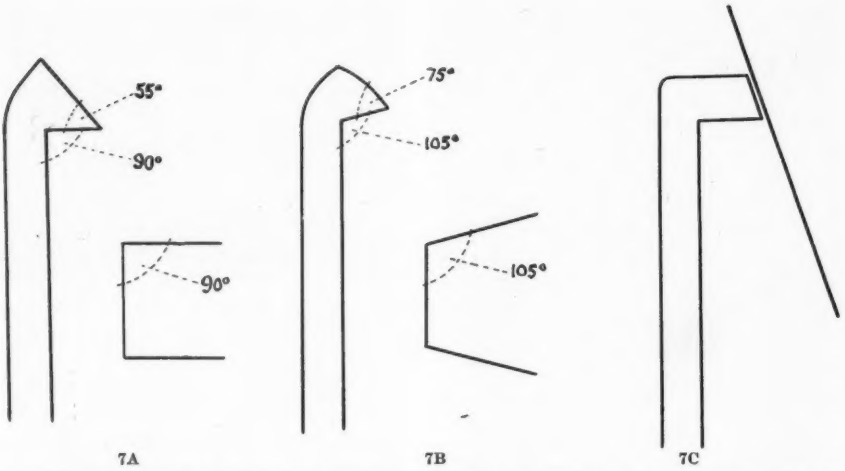


Fig. 6. Illustration of different "rake angles" of instruments and nomenclature of parts. (a) 90° rake angle; (b) Positive rake angle (smaller than 90°); (c) Negative rake angle (more than 90°).



7A 7B 7C

Fig. 7. Construction of instruments and their sharpening according to the correct rake angle. (a) 90° rake angle, (b) 105° rake angle, (c) Sharpening the end of the instrument on an arkansas stone.

surface with increasing or decreasing the distance of the shaft from the tooth. (See paper by Orban and Manella—"A Macroscopic and Microscopic Study of Instruments Designed for Root Planing"—J. Period. 27:40, 1956).

A clearance angle of at least 5° to 10° is necessary to prevent the heel of the instrument impeding the action of the cutting edge of the blade. If the clearance angle is increased, the lip angle will decrease which makes the edge of the blade thinner and thus more easily dulled.

SHARPENING THE HOE

Depending upon the construction of the different hoes on the market, a different sharpening technique might have to be used. If the rake angle of the instrument is 90° (Fig. 7a), a hand arkansas slip stone or fine india stone that has any two longitudinal surfaces of the base meeting at a right angle, may be used. The wedge-shaped slip stone may be so formed on its thickest edge (Fig. 8) by dressing it down on the silicon carbide paper. Under magnification, the stone is placed in position in contact with the instrument and with light pressure, the stone is drawn across the instrument, back and forth, for a few strokes, then examined for results.

If it is necessary to hone the heel of the blade, the instrument is positioned and carefully "wiped" with the flat surface of the arkansas stone until the correct surface is obtained. This shows up clearly under magnification. With the flat surface of the same stone, the corners of the blade are rounded to reduce the grooving tendency of a sharp corner.

If the rake angle of the hoe is more than 90°, as, for example, the Orban's hoes which are 105°, the stone used in sharpening should be so shaped as to have 105° corners instead of 90° (Fig. 7b). This can be easily done by using a wedge-shaped stone instead of a parallel-walled stone, and by polishing its edge flat.

If the hoe has a straight end (Fig. 7c), it can be sharpened on a straight arkansas stone.

SHARPENING THE FILE

The blades of the file are identical with those of the hoe, except that they are

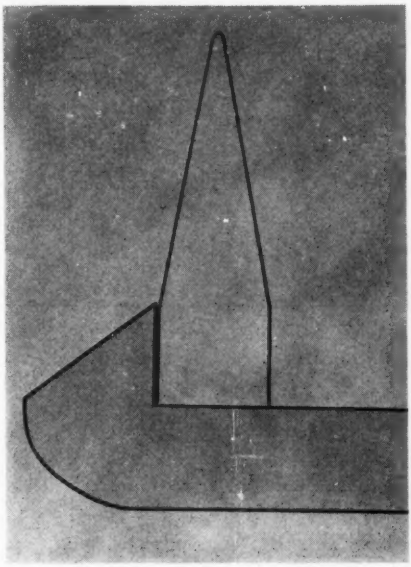


Fig. 8. Sharpening a hoe with a 90° rake angle with the back end of a slip stone.

smaller in size and due to the fact that there are several blades in a row, a different technique in sharpening is needed. The blades follow each other at different angles, depending upon the construction of the instrument. If the file is constructed according to the diagram (Fig. 9a), the wedge between two blades has an angle of 55° and the stone to sharpen these blades

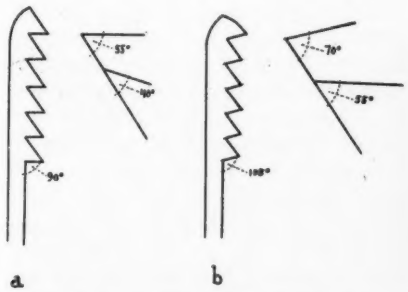


Fig. 9. Different construction of files and the principles in sharpening; (a) 90° rake angle—55° angle between two blades; (b) 105° rake angle—70° angle between two blades.

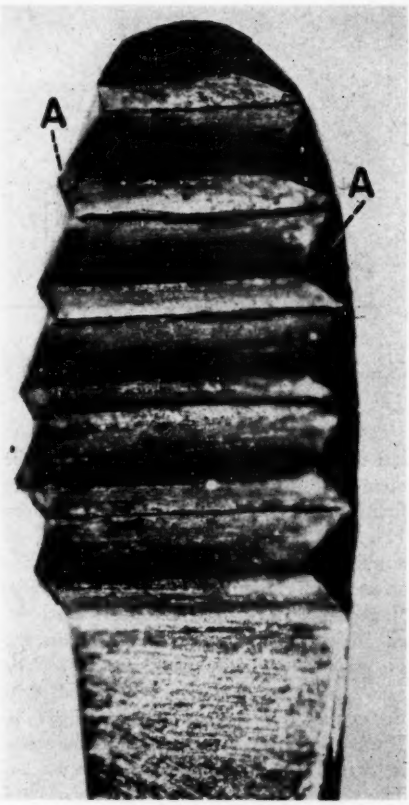


Fig. 10. Beveling the sharp lateral edges (a) of a file to prevent grooving the root surface. (The same has to be done to the hoe).

Fig. 11. Shaping a slip stone on a silicon carbide paper. The proper angle of the edge is provided by the wooden prop.

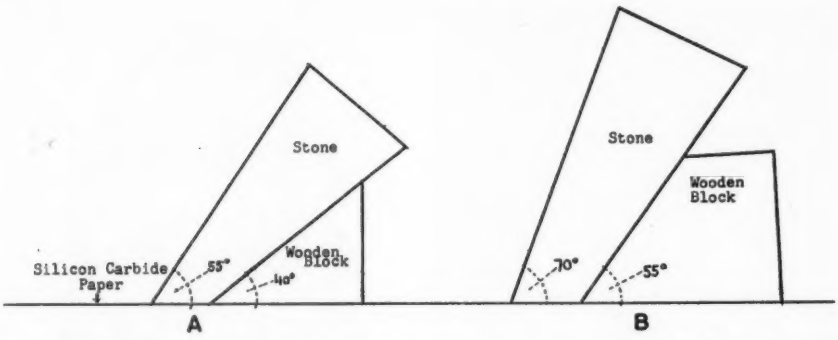


Fig. 12. Diagram of shaping the edges of slip stones according to different angles with the aid of wooden props.

has to be shaped accordingly. This can be done by using a wedge-shaped arkansas or fine india stone on a silicon carbide paper (Fig. 11), using a wooden block with an angle of 40° as a prop for positioning the stone during sharpening (Fig. 12a). The stone is propelled back and forth until its edge is perfected by the action against the silicon carbide paper (grit 120 D). The fine edge of the stone thus shaped, will fit between the blades of the file (Fig. 9a). Under magnification, this edge of the stone is "wiped" back and forth on the blades. The blade nearest the tip is done first and each one successively toward the shank. Care must be constantly exercised to maintain the proper rake angle of the blades. As with the hoe, the corners of the blades (Fig. 10) must be rounded to prevent gouging of the tooth surface.

If the rake angle of the blades is not 90°, but 105°, as seen in Figure 9b, the stone has to be shaped on the silicon carbide paper and a wooden block with 55° angle (Fig. 12b) to give the cutting edge of the stone a lip angle of 70°. If a triangular, fine, india stone (MF 114 or FF 114) is used, it has to be shaped on a truing stone to obtain the proper angles (Fig. 13). This is done first on a rough and secondly on a finer grade stone.

The end blade of a file is the one most used, and if it becomes less prominent and disfigured through repeated sharpening, it should be removed and the next blade of the file shaped to be the first.

Magnification is absolutely necessary to avoid disfiguring a file by improper application of the stone, making it inefficient in operation. The important thing is to keep the proper rake angle along the entire width of the blades. The most frequent mistake made in sharpening is the change of the rake angle to a more open angle—up to 130°, and thus making the instrument rather ineffective (Fig. 14).

SHARPENING THE SICKLE

Sickles are sharpened with mounted stones such as the ruby stones (Fig. 4a). These stones come in a variety of sizes and may be reshaped easily by rotating against a truing stone. Mounted stones are propelled either by a hand motor or a dental motor in a straight handpiece. Sharpening this type of instrument is possible without the aid of magnification, but the use of a magnifying device provides greater safety. Care should be taken to not round the edges—they should be true right angles. Using the largest stone that will fit the curved surface of the instrument is most effective, although the tip is the only part sharpened (Fig. 15a). The opposite outer surface can be sharpened with the same stone (Fig. 15b). The sides of the instru-

Fig. 13. Shaping a triangular fine india stone for the proper angle—on a truing stone.

ment seldom need reshaping. Care should be exercised to not overheat the instrument and thus ruin its temper.

The smaller sickle-shaped instruments and double-curved contra-angle sickles can be sharpened in a similar manner with smaller stones.

SHARPENING THE CURETTE

The easiest way to sharpen the curette is on the motor with a felt wheel of 3-3½ inches in diameter and ¾ of an inch thick (Fig. 16a). The motor should run absolutely true and revolving 1750 to 3500 rpm. Chrome rouge is applied (Fig. 5) to the wheel and it should rotate away from the operator (Fig. 16a & 17). Either the large end surface of the wheel or the narrower edge is used in sharpening. The curette is moved across the rotating wheel with very slight pressure in both directions, sharpening the instrument on the curved outer surfaces. Again, great care should be exercised not to overheat the instrument. With some practice, a curette can be sharpened in just a few seconds.

The curettes may also be sharpened by several other methods, either by the use of mounted stones, similar to the sharpening of the sickles (Fig. 16b) or by the use of round pencil-shaped hand stones (Fig. 16c). These are oil stones and can be obtained in different thicknesses. These are used on the flat inner surface of the curette.

Fig. 14. By improper sharpening, the angle between two blades of a file becomes wider. The blades have a wider lip angle, keep the edge longer, but are not effective.

There are also oil stones with long ditch-like grooves cut into them (Fig. 16d) in which the curved outer surface of the curettes fit.

SHARPENING THE KNIFE

Sometimes a new knife may not have a proper cutting edge along the entire blade, or a blade may have been abused in use by having been scraped against bone or tooth structure. In such cases, proper shaping of the edge may be obtained by placing the instrument on the notched instrument support and shaping the edge with an arkansas or india hand stone.

To obtain a keen edge, a medium-hard felt wheel that is 3 to 3½ inches in diameter by ¾ of an inch thick is used, the same used in sharpening curettes (Fig. 18). Apply chrome rouge to the felt wheel

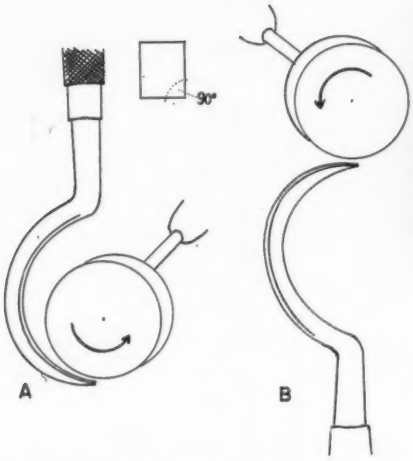


Fig. 15. Sharpening the inside (a) of a sickle with a mounted ruby stone, rotating stone away from tip. (b) Sharpening the outer edge. The correct edges are all 90°.

as needed to keep the felt covered. Chrome rouge is a fine agent that will highly polish a gingivectomy knife blade and leave a keen edge that will literally slip through tissue. The rotation of the felt wheel must always be away from the cutting edge. Both edges on each side have to be sharpened. A very light pressure is applied and the blade is kept moving to avoid heat.

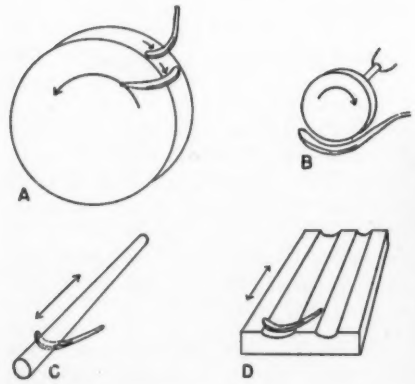


Fig. 16. Sharpening curettes—(a) On a felt wheel, the wheel turning away from the operator; (b) with a ruby stone; (c) with a pencil-shaped arkansas stone; (d) on a grooved arkansas stone.

Fig. 17. Sharpening a curette on the lateral surface of a felt wheel (chrome rouge).

The edges of the knife should then be inspected under magnification.

ADDITIONAL HINTS

All sharpened instruments should be wiped clean of foreign material before sterilization. This is best done with gauze and alcohol or some other solvent.

The ruby and india stones may be cleansed by washing them in soap and water and the arkansas stones by wiping them with oil. They may be further cleansed by boiling in kerosene.

Oil stones may be kept in a tray which has been lined with several layers of oil-saturated gauze. Oil must be of a high quality and very thin. No oil stone should be re-shaped unless saturated with oil. To do so may cause it to chip badly.

Steel files (jewelers' files) are not effective on instruments made of good steel.

Fig. 18. Sharpening the knife (on two edges, four sides)—the felt wheel is running away from the operator.

A method of rotating dull and sharp instruments for systematized usage is very helpful. The following is suggested: In two or more drawers of the dental cabinet, keep one complete set per drawer. In other convenient drawers, keep the ready supply of new and resharpened instruments. Work from one of the complete sets for any single patient, preserving the next complete drawer setup for the following patient. During that time, sterilize the first drawer setup. Whenever an instrument is dull, place it in a receptacle marked "to sharpen" and immediately replace the dull instrument with a fresh duplicate from the central supply drawers. Earmark newly resharpened instruments by placing a rubber band on the handle, or by placing them in marked towels for sterilization so that they will be returned to the central supply drawers.

SUMMARY AND CONCLUSIONS

Although only the most widely used instrument shapes have been discussed here, an adaptation of some of the methods herein described should be successful for sharpening all but the most bizarre types.

Procedures described here will keep instruments constantly ready for the most exacting clinical requirements.

Sharp instruments are essential to skilled dental procedures and facilitate clinical procedures in the following ways:

1. Lessen time of operation, in that each stroke is more effective.

2. Require less pressure of instruments to tooth or tissue, thus causing less trauma to both.

3. Lessen strain of operation to operator.

4. Give patient greater feeling of confidence and relaxation due to ease of operation.

(Acknowledgment is made to the United States Naval Dental School, Bethesda, Maryland, where photographic and other equipment and facilities were utilized for some of the illustrations in this article)

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SOUTHERN ACADEMY OF PERIODONTOLOGY MEETS APRIL 28, 29, MAY 1

The Southern Academy of Periodontology will hold its annual meeting at the Soreno Hotel in St. Petersburg, Florida, on April 28, 29, and May 1st, 1956. The program will feature Doctors Frank Beube, and Sigurd Ramfjord.

Officers for this year are Dr. Ernest L. Banks, president, Dr. Richard Chace, president-elect and Dr. Wallace Mayo, secretary-treasurer.

The Quantitative Comparison of Subgingival Curettage and Gingivectomy in the Treatment of Periodontitis Simplex

by E. M. BENJAMIN, D.D.S., *Bethesda, Maryland*

PERIODONTITIS simplex, which may be defined as a progression of gingival inflammation to include the rest of the periodontium, is treated by subgingival curettage, by gingivectomy, and various adaptations and combinations of these methods.

Despite the common usage of these techniques relatively few comparative studies are reported in the literature. Beube[1] compared interdental resection with curettage and found the average decrease in pocket depth to be two and one half times as great by surgery as by curettage. Kaplan and Mann[2] concluded that satisfactory results can be obtained by any of several methods of treatment. Methods studied were gingivectomy, curettage with escharotics, chemical coagulation and electrocoagulation. Chaikin[3] reported on 182 individual cases with pockets averaging 5.77 mm. in depth before and 1.11 mm. after treatment by curettage and 139 individual cases with pockets averaging 7.64 mm. in depth before and 1.03 mm. after treatment by gingival resection.

No matter which therapeutic device is chosen, its effectiveness is estimated by the reduction of pocket depth and the restoration of the periodontal structures to a state of health. This paper describes a quantitative method used in the evaluation of the reduction of pocket depth thirty days after treatment in a series of patients with periodontitis simplex treated in alternate quadrants of the mouth by gingivectomy and curettage.

METHOD

Patients 25 to 60 years of age who had been referred to the Clinical Center dental department for consultation and treatment were considered for inclusion in the study. Each patient was given a complete medical and dental examination. The medical examination included a routine physical examination, detailed blood and urine tests, X-rays, and special studies as indicated for the purpose of excluding diseases such as diabetes and blood dyscrasias, which are believed to complicate the response of the periodontium to treatment. After a complete clinical and radiographic dental examination six individuals with an uncomplicated periodontitis, which was in neither an incipient nor a terminal stage, were chosen for study. There were four male and two female patients whose ages were 28-44.

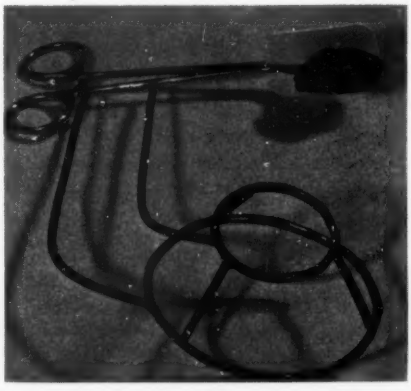

Fig. 1. X-ray positioner with compound bite and film ready for placement in the mouth.

Each patient selected was then given a periodontal examination consisting of pocket measurements, standardized bitewing X-rays and study models. The models were made from full mouth alginate impressions poured in plaster of paris. The pocket measurements were done with a periodontal probe calibrated in millimeters.

National Institute of Dental Research, National Institutes of Health, Public Health Service, U. S. Department of Health, Education and Welfare.

TABLE I

Average Pocket Depth in Six Patients Before Treatment in Alternate Quadrants of the Mouth by Curettage and by Gingivectomy.

	Patient						All Patients
	A	B	C	D	E	F	
Quadrants Treated by Curettage							
Number of teeth present	8	8	8	6	8	7	45
Average pocket depth, millimeters	3.06	3.06	4.06	3.36	3.81	3.31	3.04
Quadrants Treated by Gingivectomy							
Number of teeth present	8	8	8	8	8	7	47
Average pocket depth, millimeters	3.12	3.12	3.92	3.11	3.67	3.48	3.40

Six measurements were made around each tooth on the mesio-facial, facial, disto-facial, mesio-lingual, lingual and disto-lingual aspects. The probe was kept parallel to the long axis of the tooth during this procedure. The facial measurements were repeated independently by two other clinicians in order to find out how they might compare in assessing pocket depth reduction. Table I shows average pocket depth and number of teeth for each patient before treatment.

A film positioner and standardized processing technics were used in order to have comparable X-ray films. This appliance was attached to the teeth by a reusable compound bite to allow reproduction of X-ray cone and film position. Measurements were then made from a fixed point on the tooth to the corresponding bone level. (Fig. 1, 2 and 3).

On the study casts measurements were made from the crest of the gingiva to the tip of a cusp on the facial and lingual aspects of each study tooth. Hereafter in this report this distance is designated as the length of the clinical crown. The measurement was made from the same point on the gingival crest which had previously been used in measuring pocket depth.

One upper and one lower "study quadrant" on opposite sides of the mouth were treated by gingivectomy and the remaining two quadrants by curettage. Treatment was confined to teeth posterior to the cuspid. Pairs of quadrants to be treated by each procedure were determined by random choice.

The gingivectomy was performed by

Fig. 2. X-ray positioner in the mouth with x-ray tube in place immediately before exposure.

TABLE II

Average Reduction of Pocket Depth in Six Patients Treated in Alternate Quadrants of the Mouth by Curettage and by Gingivectomy.

	Patient						All Patients
	A	B	C	D	E	F	
Quadrants Treated by Curettage							
Number of teeth present	8	8	8	6	8	7	45
Average reduction in pocket depth, millimeters	.85	.31	1.41	1.28	1.18	.38	.90
Quadrants Treated by Gingivectomy							
Number of teeth present	8	8	8	8	8	7	47
Average reduction in pocket depth, millimeters	1.69	1.13	1.56	1.60	2.10	1.43	1.59

making an incision on the facial and lingual aspects of the gingiva based on the depth of the pockets. Debridement was done and a surgical pack placed. The pack remained in place for seven days; at the end of this time it was replaced and allowed to remain seven more days before removal. The curettage was done in three sittings. The objectives were to plane the root surface, remove calculus, debris, granulomatous tissue and the epithelial lining of the pocket. All patients were treated alike with respect to instrumentation, number of sittings, and medications used. The same home care procedures were recommended for all patients.

Two strips of gingivectomized tissue from each patient were processed for pathologic study. The specimens were fixed in 10% formalin and cut into approximately 2 mm. pieces in a buccal lingual plane so that as many crevicular and pocket surfaces as possible would be revealed. Sections stained with hematoxylin and eosin were then examined microscopically in order to confirm the clinical diagnosis and for the possible detection of abnormalities.

One month after treatment was com-

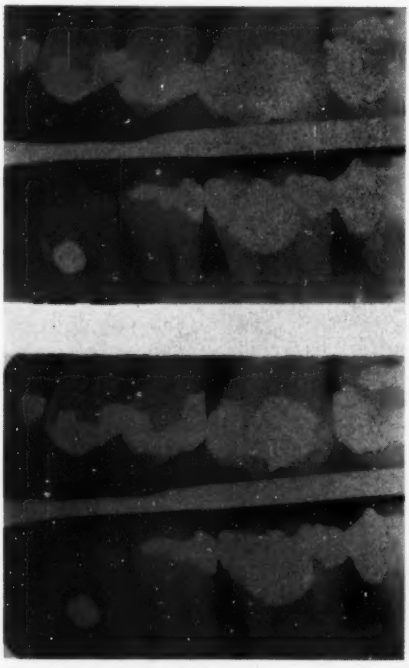

Fig. 3. Standardized bite-wing x-ray films taken before and after treatment in alternate quadrants of the mouth by curettage and by gingivectomy. (Top before, bottom after).

TABLE III

Average Increase in Length of the Clinical Crowns of Teeth in Six Patients Treated in Alternate Quadrants of the Mouth by Curettage and Gingivectomy.

	Patient						All Patients
	A	B	C	D	E	F	
Quadrants Treated by Curettage							
Number of teeth present	8	8	7*	6	8	7	44
Average increase in length of clinical crown, millimeters	.56	−.19	.71	.25	.06	.21	.26
Quadrants Treated by Gingivectomy							
Number of teeth present	8	8	7*	8	8	7	46
Average increase in length of clinical crown, millimeters	.56	.44	1.07	1.13	.81	.79	.79

*1 tooth unmeasurable on study cast.

pleted measurements were repeated on pocket depth in the mouth and length of the clinical crown on study casts. A second set of standardized bite-wing X-rays was made and measured as previously described.

RESULTS

There was favorable response to both types of treatment. Table II gives the average reduction in pocket depth per tooth for each patient by type of treatment. Reduction in pocket depth after 30 days was consistently greater in patients treated by gingivectomy than in those treated by curettage. An analysis of variance discloses that this series of differences is significant at $P = .01$ level for 1 and 5 degrees of freedom.

No gross changes or trends were observed in the bone from the measurement and interpretation of the standardized bite-wing X-rays.

Microscopic findings were compatible with the clinical diagnosis. There was no evidence of any abnormality other than periodontal disease.

Both gingivectomy and curettage elongated the clinical crown in this series of patients. There was a greater increase in clinical crown measurements following gingivectomy than following curettage in the majority of cases. These data are shown in Table III. The differences are significant at the $P = .01$ level for 1 and 5 degrees of freedom.

The results of the comparison of clinicians in assessing the pocket depth reduction by curettage and gingivectomy are given in Table IV. This comparison is based on facial readings since only the principal investigator did the complete measurements. It will be noticed that the facial pocket depth reductions as measured by clinician *A* are much higher, both for curettage and gingivectomy, than the reductions as measured by clinicians *B* and *C*. Clinician *A* measured a reduction of pocket depth of 23 mm. for curettage and 46 mm. for gingivectomy. The corresponding figures for clinician *B* are 17 and 38 and for clinician *C*, 19 and 34. All three agreed that gingivectomy reduced pocket depth about twice as much as curettage.

TABLE IV

Total Facial Pocket Depth Reduction in Millimeters, Six Patients Treated in Alternate Quadrants by Curettage and Gingivectomy, as Measured Independently by Three Clinicians.

	Clinician A		Clinician B		Clinician C	
	Quadrants Treated by					
Patient	*Curettage*	*Gingivectomy*	*Curettage*	*Gingivectomy*	*Curettage*	*Gingivectomy*
A	5	9	1	5	−2	1
B	2	9	−3	2	−3	3
C	5	5	8	5	12	10
D	7	12	6	12	6	7
E	2	7	1	8	3	8
F	2	4	4	6	3	5
	23	46	17	38	19	34

DISCUSSION

Elimination or reduction of pocket depth is a desirable end result because the soft tissue wall contributes nothing to the support of the tooth and the pocket may harbor bacteria and debris which aid progression of the disease. In the present series of cases, examination after 30 days showed that gingivectomy had better fulfilled this requirement, since consistently greater pocket reductions were obtained by gingivectomy than by curettage in each of the six patients studied.

Both treatments are followed by elongation of the clinical crowns, providing the clinical crown is defined as that portion of the tooth protruding into the oral cavity from the free margin of the gingiva. Increase in clinical crown measurement can be expected following treatment due to resolution of edema and congestion and actual removal of involved tissue. There were discrepancies between the total reduction in pocket depths and consequent elongation of clinical crowns. Whether this was due to epithelial reattachment cannot be determined on the basis of the present observations. (Tables II and III).

It is planned to re-evaluate these cases six months following treatment.

The six patients included in this study were all free of acute, chronic, systemic and hereditary diseases. It is planned to extend the investigation to groups with known systemic or other disease to determine if deviation to treatment response may occur. In this category, participants with diabetes, cardiovascular, primary renal disease or arthritis might constitute a good basis for comparison.

SUMMARY

A method for comparing two types of periodontal treatment has been described by which valid data may be obtained with a relatively small number of patients. The procedure is based on random assignment of treatments in alternate quadrants of a mouth thereby eliminating most of the variation in patient response. Application of this method to a comparative evaluation of subgingival curettage and gingivectomy in a series of patients one month following treatment demonstrated that gingivectomy had consistently reduced pocket depth a greater amount than curettage.

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The author gratefully acknowledges the help of the Clinical Center Dental Department under direction of Dr. Ralph S. Lloyd in carrying out this project. N. C. Leone, M.D. cooperated in performing the physical examinations. H. R. Stanley, Jr., D.D.S. did the histopathologic evaluations. Special thanks is due J. E. Lieberman, M.S. for statistical planning, computation and interpretation of data.

Periodontosis—A Review of the Literature

by JOSEPH G. YOUNT, D.D.S.,* AND CHARLES M. BELTING, B.A., D.D.S., M.S.,* *Chicago, Ill.*

PERIODONTOSIS, according to the Nomenclature Committee of the American Academy of Periodontology,[18] is a general term used to indicate a "degenerative, non-inflammatory destruction of the periodontium originating in one or more of the periodontal structures, and is characterized by the migration and loosening of the teeth in the presence or absence of secondary epithelial proliferation and pocket formation or secondary gingival disease."

The first published description of a non-inflammatory type of periodontal disease was made in 1920 by Gottlieb. He termed this condition "diffuse atrophy of the alveolar bone," and pointed out that atrophy of the alveolar bone and widening of the periodontal membrane were the chief characteristics of this disease. Resorption of the cementum might also occur, but clinically, the earliest sign was usually migration of the affected teeth. The first case which he described was in an individual who had suffered from epidemic influenza, and he suggested that such a systemic disturbance might be an important etiological factor.[8]

Box[3] in 1924 described a chronic and progressive lesion of the pericementum which results in the "rarefaction and destruction of the alveolar bone." This condition he termed, "rarefying pericementitis fibrosa." The histopathological changes resembled in many ways those of Gottlieb's "diffuse atrophy." However, he maintained that these changes occurred during the process of a very low-grade chronic inflammation. This bore no relation to any inflammatory changes in the gingiva. In his opinion, the causative factor was "overstress," which results in this type of pericementitis fibrosa. He suggested that other unknown etiological factors might be involved.

Gottlieb[9] in 1946 in an attempt to explain the etiology of "diffuse atrophy," emphasized the importance of the vitality of the cementum in the development of periodontal disease since it is this tissue which maintains the connection of the tooth to the alveolar bone. Loss of vitality of the cementum, which in the last analysis means cessation of cementoblastic activity, would result in loss of fiber connection be-

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tween cementum and alveolar bone. The concomitant lack of functional stimulus to the alveolar bone, in turn, would result in resorption.

Introduction of the term "periodontosis" for the condition which previously had been referred to as "diffuse atrophy" and "rarefying pericementitis fibrosa" was made by Orban and Weinmann[15] in 1942. The reason for their terminology was based upon their observations of a primarily degenerative condition rather than an inflammatory one. They described three stages in the development of this degenerative periodontal disturbance based upon histopathological examinations of human jaws obtained at autopsy. The three stages of periodontosis as described by Orban and Weinmann may be summarized as follows:

First Stage: The first stage of periodontosis is characterized by the degeneration of the principal fibers of the periodontal membrane. The first consequence of this process is the cessation of the formation of cementum. Simultaneously, resorption of the alveolar bone sets in due to lack of functional stimuli from the tooth as well as an increase in tissue pressures resulting from the accumulation of edema and the proliferation of capillaries. This increase of tissue pressure also accounts for the migration of the tooth from the affected part of the alveolar bone.

Second Stage: The second stage is characterized by the rapid migration of the epithelial attachment along the affected cementum. There also may be a proliferation of the epithelial remnants in the periodontal membrane. With the epithelial proliferations, the first sign of an inflammatory reaction becomes evident. The inflammation is explained by the penetration of toxins from the gingival crevice into the underlying connective tissue. These toxins follow the course of the capillaries as well as the epithelial structure. The second stage cannot be distinguished, clinically, from the first stage. Both stages are of short duration but they may differ in their consequences, however. The first stage may be completely repaired providing the primary etiological factor ceases, whereas the second stage must lead to the third stage.

Third Stage: The degeneration of the epithelial tissue at the bottom of the gingival crevice causes the development of deep pockets and thus the third stage follows in the development of periodontosis. The inflammatory reaction increases and leads to an obliteration of the primary symptoms of degeneration. Large portions of the supporting tissues are destroyed and even normal occlusal forces cause secondary traumatic changes. The third stage is most frequently observed clinically and is referred to as Periodontitis Complex by Orban.[16]

CLINICAL AND RADIOGRAPHIC FEATURES

Clinically the appearance of periodontosis will vary according to the stages in which the condition is seen. In its early stages, a vertical or arc-like resorption of one side of the interdental septum occurs. There is a roentgenographic widening of the periodontal membrane space and a lack of definition of the lamina dura. This attack may involve a single tooth, a group of teeth, or all of the teeth. The incisor or molar areas are the sites of earliest involvement.[13] Other areas may or may not later become involved. The maxillary incisors loosen and migrate labially and distally with diastema formation. The loosening and migration may be accompanied or followed by extrusion of the involved teeth.

There is disagreement in the literature as to the relationship of periodontal disease to caries. Kesel,[11] however, points out that the consensus favors the concept that caries and periodontal disease are antagonistic processes. It is a common clinical experience to see cases of periodontosis in which the teeth are caries immune.

Pockets may not be detectable in the early or degenerative stage of periodontosis even though there is roentgenographic evidence of a vertical type of interdental

bone resorption. The gingival tissues in these cases are pale pink, firm and normal in appearance with relatively little calculus present. A little later, after pockets have developed, the gingival tissues may still exhibit a pale pink, non-inflammatory appearance. The pockets commonly contain little or no subgingival calculus and very little, if any, pus can be expressed from the pockets.

As the disease progresses to a late or inflammatory stage, subgingival calculus deposits become abundant and pus can be expressed freely from the pockets. Differential diagnosis from other forms of periodontal disease at this state often is difficult. So much periodontal destruction may already have occurred that the characteristic signs of periodontosis will have been obliterated.

ETIOLOGY

The exact nature of the etiology of periodontosis remains obscure. Since the known local etiological factors do not explain the disease, it is reasoned by most investigators that the pathologic changes seen in periodontosis are systemic in origin. Any one or a combination of such systemic disturbances as nutritional deficiency, endocrine disorder, metabolic disturbance, or debilitating disease could result in a lowered resistance of the periodontal tissues to their local environment. The theory of systemic etiology, however, does not explain those cases of periodontosis wherein thorough medical history and examination fails to reveal any systemic disturbance. The etiology of such cases may be explained on the basis of such generalizations as an "inherited inferiority of the dental organ"[17] or a "negative bone factor."[4] Miller[14] recently has emphasized the importance of multiple influences in the etiology of periodontal disease. He points out that removal of any one of the etiologic factors, either by medical therapy or by spontaneous cessation, may result in improvement or arrest of the condition.

EXPERIMENTAL STUDIES

Diabetes Mellitus: An association between diabetes and periodontal changes such as those seen in periodontosis has been referred to in the literature for many years. The exact nature of that assumed relationship has never been described, however. Glickman[5] has tended to dispel this assumed association as a result of a histological study of 121 albino rats used to determine the effect of experimentally induced diabetes upon the periodontal tissues. A brief summary of his observations are as follows:

1. The nature and incidence of gingival disease is not altered by diabetes.

2. Varying degrees of osteoporosis of alveolar bone were noted in some but not in all cases.

3. In those cases wherein osteoporosis was noted in the alveolar bone, it was accompanied by similar changes in other bones of the skeleton.

4. No notable pathologic changes in the periodontal membrane or cementum were observed.

In correlating the above findings with the disease as it occurs in human beings, Glickman believes that (1) diabetes is not responsible for the onset or the continuation of gingival changes; (2) periodontal disease seen in diabetic individuals presents no clinical or microscopic features which warrant its classification as a unique disease entity; (3) the absence of periodontal disease in a large percentage of diabetic individuals discourages the assumption that whenever periodontal disease occurs in diabetics its origin is motivated by the diabetes.

Three possibilities are suggested which could explain the presence of periodontal disease in diabetic individuals:

1. The periodontal disease may have been present prior to the onset of diabetes.

2. The periodontal disease may be the result of the local environment.

3. The periodontal disease may be associated with a systemic disturbance unrelated to the diabetes.

Vitamin C Deficiency: Chronic vitamin C deficiency in guinea pigs has been reported by Boyle, Bessey, and Wolbach[2] to simulate the condition of diffuse alveolar atrophy of the alveolar bone. They found that teeth were looser and that the periodontal membrane space as seen in the roentgenogram was wider than in the control animals. Histologically, there was extensive osteoclastic resorption coupled with an inability of the osteoblasts to form bone and fibroblasts to form collagen fibers.

Glickman[6] confirmed and elaborated upon the findings of Boyle et al using guinea pigs with acute vitamin C deficiency. He observed a loss of tooth supporting tissues throughout the jaws in an absence of gingival inflammation and pocket formation similar to the conditions seen in diffuse alveolar atrophy. He concluded, therefore, that vitamin C deficiency itself is not responsible for the initiation of, or increase in, the incidence of marginal gingivitis or pocket formation. The concomitant occurrence of marginal gingivitis and pocket formation in acute vitamin C deficiency is not attributable to the deficiency alone but indicates the presence of a complicating factor. However, when pocket formation does occur in acute vitamin C deficiency, it progresses to a greater depth than it does in the control animals under comparable local conditions.

Total Protein and Vitamin B Deficiency: Goldman[7] studied the effect of total protein and vitamin B deficiency on a group of monkeys and noted marked changes in the periodontal tissues simulating those seen in periodontosis. Roentgenographically the periodontal membrane space was widened greatly, and microscopically the principal fibers of the periodontal membrane were missing. Osteoporosis was present and the gingival tissues showed dense inflammatory infiltration with ulceration.

Traumatism: The presence of vertical type resorption on one side of the interdental septum together with occlusal interference has led some writers to believe that traumatic occlusion is the cause of the clinical and roentgenographic features seen in periodontosis. In order to study this hypothesis, Gottlieb and Orban[10] conducted extensive experiments on dogs. The direction of occlusal stresses on the teeth was altered by means of crowns made with sloping planes in such a manner that the crowned teeth were in traumatic relation with their opponents. Their findings were similar to the changes seen in orthodontic tooth movement. Within 24 hours, the periodontal membrane space was narrowed on the side of pressure and widened on the side of tension. Continued excessive stress resulted in obliteration of the periodontal membrane space and necrosis of the alveolar bone in the area of pressure. This was followed by undermining resorption of the necrotic alveolar bone until the normal functional width of the periodontal membrane was re-established. On the side of tension, bone opposition occurred until the normal width of periodontal membrane space also was re-established. In other words, the tooth was moved into a new position of equilibrium with its opponent.

It is of particular interest to note that no inflammatory gingival changes or pocket formation occurred as a result of the traumatic forces placed on the teeth. The traumatic changes in the supporting tissues were localized to the periodontal membrane and the alveolar bone. Up to the present time, experimental reproduction of the periodontal changes seen in periodontosis from traumatic influences has not been reported. Therefore, the effect of traumatism as an etiologic factor in the production of periodontosis is uncertain except as one of aggravation.

EPIDEMIOLOGY

There are relatively few reports on the prevalence and incidence on periodontosis in an adult population. Those reports available indicate a wide range in its prevalence

due to differences in the health and size of the sample populations examined and variations in the criteria of assessment.

Using 568 people of India from 9 to 60 years of age, Marshall-Day and Shourie[12] in 1949 reported periodontosis present in about 35 per cent of their cases. There seems to be little doubt that this high incidence is associated with the malnutrition of their sample population.

More recently, Belting, Massler, and Schour[1] using 5014 average healthy men in Chicago 20 to 80 years of age reported that periodontosis was present in only 2 per cent of their cases up to 30 years of age. At that age, the incidence rose rapidly to reach a peak of 22 per cent of the population affected at 45 years of age. Thereafter, the incidence decreased as tooth loss increased. On the basis of their findings, they predict that 50 per cent of all men will have some form of periodontal disease or be edentulous as a result of it, by 45 years of age. These facts, together with the promising advances in caries control, emphasize the challenge that further study of periodontal disease offers to dental research workers today.

TREATMENT PLANNING AND PROGNOSIS

The problem of planning treatment and making a prognosis for periodontosis is a complicated one due to the multiform character of the disease.[17] Efforts to save the teeth in a case of rapidly progressing periodontosis often end in failure, whereas a history of slow progress tends toward a better prognosis. The history of the condition, therefore, is of utmost importance in arriving at a suitable plan of treatment.

There is a general agreement among all writers on the subject that the health of the patient has a direct bearing on the success of periodontal therapy. Therefore, any health disability should be brought under competent medical treatment before proceeding with periodontal therapy.

The local methods of treatment for periodontosis do not vary significantly from the well established principles of periodontal treatment in general; namely therapeutic root planing, pocket elimination, correction of restorative defects, establishment of occlusal balance, splinting of teeth when indicated, and instruction in oral physiotherapy. Adjustment of occlusion may be more important for cases of periodontosis than periodontitis since traumatic influences are more aggravating in this condition.[17]

The oral hygiene of the patient, and particularly his interest in his oral health, are conditioning factors in coming to a decision of whether or not periodontal treatment will be successful.

In general, it may be stated that the prognosis is poor for teeth that have lost more than half their alveolar support although this statement should not be so construed as to mean that treatment for the condition, therefore, is hopeless or contraindicated. By various types of surgery, such as curettage, gingivectomy, and flap operation, many of these teeth can be saved for many years of healthy function. Hopelessly involved teeth, of course, should be removed, but replacements, in cases of periodontosis, should be planned with prudence to forestall a possible prosthetic failure within a relatively short period of time. In spite of the most carefully planned treatment procedure, failures in treatment occur even in the hands of skilled therapists.

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COLORADO DENTAL FOUNDATION SEMINAR

July 1 to 5, 1956

The Colorado Dental Foundation announces that its Tenth Annual Seminar on Periodontology will be held at Colorado Springs, Colorado, from July 1 to 5, 1956. The program as planned will consider several aspects of periodontology, with those attending the seminar as participants.

One of the features of the meeting will be a panel discussion with Drs. Henry M. Goldman (Boston), Charles H. M. Williams (Toronto), Harry Sicher (Chicago), Maynard K. Hine (Indianapolis), and Balint Orban (Colorado Springs). The guest of honor will be Dr. Edgar D. Coolidge of Chicago.

For details address the Colorado Dental Foundation, 629 North Nevada Avenue, Colorado Springs, Colorado.

Book Review • • • •

THE MANAGEMENT OF ORAL DISEASE

A Treatise on the Recognition, Identification and Treatment of Diseases of the Oral Regions *by* JOSEPH L. BERNIER. *825 pages, 1001 text illustrations, 5 color plates. C. V. Mosby Co., St. Louis, 1955. $15.00.*

This text was designed as ". . . a guide in the teaching of oral pathology which would be in keeping with the newer definition of that specialty." The reviewer was surprised to learn that dental and periodontal pathology are considered to be foreign to this field. With some exceptions the first third of the book is devoted to the pathology of dental and periodontal tissues in the broad sense. Some shortcomings of the chapters on dental caries, periodontal diseases, and pulp and periapical tissues, are rather evident. Nineteen pages of text are devoted to dental caries, including its "treatment" or prevention. Seven of these pages are direct, fine-print quotations from a report of a conference held in 1948, and there is a dearth of information developed since that time. At the end of this chapter, thirteen pages of references are presented in fine print to no apparent purpose.

Chapter eight which treats on "The Pathology of Periodontal Disease" has thirty-two pages of text purported to deal with etiology and histopathology. In this chapter, seven pages are devoted to fine-print quotations which appear to represent a running diary of the opinions of a committee on nomenclature. One statement in this chapter is italicized as follows: "Most important is the fact that calculus formation is the result of gingival inflammation and not its cause." Yet this statement seems to be contradicted in subsequent discussion.

The author states at one point that ". . . the oral pathologist, . . . has developed new horizons relating largely to soft tissue disease." This is the true forte of this text. The last two-thirds of the twenty-two chapters are devoted largely to lesions of the mouth due to local or systemic disease. Developmental defects, lesions of infectious, allergic, and traumatic origin, those reflecting the presence of systemic disease, cysts and benign and malignant tumors of the soft and hard tissues of the region are very well treated, with excellent gross, radiographic and photomicrographic illustrations. The twenty-nine color prints are of good quality and carefully chosen, but it is curious to note that several of these pictures are duplicated elsewhere in the text in black and white, and often in reversed position.

This is an excellent reference for students and practitioners for use in the diagnosis and management of the vast variety of lesions of the oral mucosa, salivary glands, and bones of the jaws. The author is properly recognized as an eminent authority in the field of oral pathology. D.F.M.

Announcements • • • •

SPRING CONFERENCE OF THE AMERICAN ACADEMY OF PERIODONTOLOGY

An excellent program for the annual spring conference of the American Academy of Periodontology will be presented at the University of Michigan in Ann Arbor on April 30, May 1, 2, 1956. All members of the Academy are eligible to attend, and each member is entitled to sponsor one guest. Guests may attend only if sponsored by members.

Program

MONDAY, April 30

8:00 a.m.- 9:00 a.m.	REGISTRATION	Room 2004 Kellogg Building
9:30 a.m.-12:00 noon and 1:30 p.m.- 4:00 p.m.	THE ROLE OF NUTRITION IN PERIODONTAL DISEASE Harry Roth, D.D.S., F.A.C.D. Assistant Professor of Periodontia and Oral Medicine College of Dentistry, New York University	

TUESDAY, May 1

9:00 a.m.-12:00 noon	BONE FORMATION AND DESTRUCTION Harry Sicher, M.D., D.Sc. Professor of Anatomy and Histology Chicago College of Dental Surgery, Loyola University	
1:30 p.m.- 4:00 p.m.	RADIOACTIVE ISOTOPES IN DENTAL SCIENCE Herbert J. Bartelstone, D.D.S. Assistant Professor of Pharmacology College of Physicians and Surgeons, Columbia University	
6:00 p.m.	SOCIAL HOUR AND DINNER L. Hart Wright, LL.M. Professor of Law University of Michigan	Michigan Union

WEDNESDAY, May 2

9:00 a.m.-12:00 noon	PERIODONTAL PACKS AND THEIR APPLICATION W. G. McIntosh, D.D.S. Associate Professor of Periodontology School of Dentistry, University of Toronto	
1:30 p.m.- 4:00 p.m.	MOVEMENT OF TEETH—AN IMPORTANT PART OF PERIODONTAL THERAPY Leonard Hirschfeld, D.D.S. Assistant Clinical Professor Periodontology School of Dental and Oral Surgery, Columbia University	

Members planning to enroll should fill out an application and mail it *immediately to Dr. William R. Mann, W. K. Kellogg Foundation Institute: Graduate and Postgraduate Dentistry, University of Michigan, Ann Arbor, Michigan.* The fees for this course—for

both members and guests—are $30.00 for residents of Michigan and $40.00 for non-residents and are due with this application. Checks or money orders should be made payable to the University of Michigan.

The applicant should write to the Michigan Union, 530 South State Street, Ann Arbor, Michigan, to make a room reservation, giving the time of arrival and departure. He should mention that the purpose of his visit to Ann Arbor is to attend the conference of the American Academy of Periodontology. The staff of the W. K. Kellogg Foundation Institute is not permitted to make reservations for the applicants.

THE AMERICAN INSTITUTE OF DENTAL MEDICINE

The next Annual Meeting of the Institute will take place at El Mirador, Palm Springs, California, November 4 to 8, 1956. The faculty will consist of:

DR. FRANCIS L. CHAMBERLAIN, Associate Clinical Professor of Medicine, the University of California, San Francisco, who will speak on cardiovascular disease, with all its implications for the personal health and welfare of the dentist and physician, as well as emergencies in professional practice. He will also discuss the problem of fat metabolism (closely related to that of cardiovascular disease), and problems of geriatrics.

DR. MILTON B. ENGEL, Associate Professor of Orthodontics, the University of Illinois, College of Dentistry. He will consider the structure of connective tissue—morphological, chemical and psysiochemical; the labile behavior of the connective tissue in health and disease; connective tissue and the milieu interieur; the formation and resorption of bone; and the implications of these general ideas in dentistry.

DR. DONALD A. KERR, Professor of Oral Pathology and Periodontia at the University of Michigan, has suggested the following subjects: The pathology of traumatic temporomandibular arthritis produced by traumatic occlusion; gingivitis, its differential diagnosis and treatment; and keratotic lesions of the oral cavity.

DR. HELMUT A. ZANDER, Professor of Periodontology, the University of Minnesota, will discuss the rationale of the prevention and treatment of oral diseases which will include such subjects as: tissue reaction to dental calculus and reaction of periodontal tissues to filling materials; mechanism of healing of periodontal lesions; and effects of restorative dentistry on the pulp and management of pulp exposures.

DR. S. I. HAYAKAWA, San Francisco State College, is well known throughout the country as the author of numerous books and publications in the field of general semantics. He will discuss: Why we don't behave like human beings; The self-concept: why we reject some ideas and welcome others; Communication as a two-way process; Success and failure in communication.

All Seminar lecturers will participate in a round table forum discussing the application of their subject to the practice of Dental Medicine. Because of the mounting interest in this annual meeting of the Institute, early registration is indicated. Applications and full information may be secured from the Executive Secretary, Miss Marion G. Lewis, 2240 Channing Way, Berkeley 4, California.

NEW YORK UNIVERSITY COLLEGE OF DENTISTRY

A physiologically functioning occlusion is a primary objective of dentistry. This may be achieved through the recognition and correction of traumatic occlusion. A course teaching the techniques to obtain this objective and their application to the general practice of dentistry is offered June 11-15, 1956. The subject matter includes occlusal equilibration and its relation to operative dentistry, dental prosthesis, temporary and permanent splinting, and patient management.

Tuition: $200.00. Fee includes books, instruments, social events, and luncheons. A deposit of $25.00 must accompany the application form. Enrollment limited. Other courses relating to periodontia and oral medicine are offered periodically. For details, write the Director of the Postgraduate Division.

Address: New York University College of Dentistry, Postgraduate Division, 209 East 23d Street, New York 10, N. Y.

NORTHWESTERN UNIVERSITY
CLINICAL APPLICATION OF HISTO-PATHOLOGY

April 11, 12, 13, 1956

This course is designed to familiarize the dentist with the clinical application of oral histo-pathology. It will be presented as a series of lectures and the demonstration of various lesions in the living patient. Biopsy technique will be discussed, demonstrated, and finally the procedure will be performed by the participants on prepared patients. The subjects to be discussed will include benign and malignant tumors, odontogenic tumors and cysts, oral manifestations of systemic disease and anomalies. A box of colored kodachrome 2x2 lantern slides of oral tumors will be provided and will become the property of the participants.

Faculty: J. C. Calandra, Ph.D., M.D., Professor and Chairman of the Department of Pathology and Bacteriology. Joseph L. Bernier, D.D.S., Chief, Oral Pathology Branch, Armed Forces Institute of Pathology. O. H. Stuteville, D.D.S., M.S.D., M.D., Professor of Maxillofacial Surgery. Arthur Elfenbaum, D.D.S., Professor Emeritus of Diagnosis. R. W. Tiecke, D.D.S., M.S., Associate Professor of Pathology.

Registration limited to 15.

Tuition: $100.00.

All communications regarding this course should be directed to

Director of Dental Postgraduate Study
Northwestern University Dental School
311 East Chicago Avenue
Chicago 11, Illinois

COLUMBIA UNIVERSITY

A course on the Principles of Occlusion, (PD 429), consisting of lectures, seminar conference and group participation, and clinical demonstrations will be given by Professor Lewis Fox and associates on May 16, 17, and 18, 1956 at Columbia University School of Dental and Oral Surgery.

This course is designed to present the fundamentals of occlusion of the teeth in relation to the physiology and pathology of the periodontal supporting tissues. The entire course will be directed toward correlating the principles of occlusion to clinical criteria and therapeutic endeavors.

The fee is $150. Registration must be made by March 15, 1956. For further information write to Postgraduate Division, School of Dental and Oral Surgery, 630 West 168th Street, New York 32, New York.

WESTERN RESERVE UNIVERSITY SCHOOL OF DENTISTRY

The Departments of Periodontology and Crown and Bridge announce a three day course, June 18, 19, 20, 1956 in Principles of Occlusion. The course consists of lectures, seminar conferences and clinical demonstrations and is under the direction of Lewis Fox, D.D.S. of South Norwalk, Conn.

Tuition fee for the course is $150.00, and the class is limited to twenty.

All checks should be made payable to Western Reserve University, and directed to The Registrar, Western Reserve University School of Dentistry, Cleveland 6, Ohio.

UNIVERSITY OF PENNSYLVANIA

The Graduate School of Medicine of the University of Pennsylvania and the Riesman Dental Clinic, Beth Israel Hospital, Boston, Massachusetts announce the twenty-month graduate training program in Periodontology. This course is under the chairmanship of Professor Henry M. Goldman.

This course consists of one academic year at the Graduate School of Medicine, with emphasis in the sciences basic to dentistry and clinical periodontology. The second year, at Beth Israel Hospital, will be devoted primarily to the clinical practice of this specialty and to research. A certificate will be awarded at the end of the second year upon successful completion of the course.

This plan meets the standards of graduate education of the American Board of Periodontology. It is designed for those interested in teaching as well as in specialized practice.

Letter to the Editor • • • •

The recent article by Miller, Thaller, and Soberman on "The Use of the Minnesota Multiphasic Personality Inventory as a Diagnostic Aid in Periodontal Disease—a Preliminary Report" J. Periodontology 27:11, 1956, was very interesting especially since it corroborated my findings published 3 years ago in your journal (Manhold, J. Report of a Study on the Relationship of Personality Variables to Periodontal Disease. J. Periodontology, 24:248, 1953). Furthermore, in the light of this fact I believe that Dr. Miller and his group either were unaware of, or missed the significance of, their results.

Miller et al make the statement in their article that ". . . . . if some method could be used to evaluate the degree of emotional involvement, perhaps another valuable instrument could be added to our armamentarium for the diagnosis and treatment of periodontal disease."

The fact which this group has missed is that their results, following those of Manhold's, present the possibility of such a method becoming a certainty because their results present excellent corroboration of those earlier presented by Manhold. Miller et al. have found a relationship between the anxiety existent in a group of persons, as demonstrated by psychological tests, and their periodontal pathology. Manhold previously in 1953 had found a similar relationship. He demonstrated a relationship between neurotic conditions as measured by another psychological test and pathological periodontal conditions. However, it is a well accepted psychological fact that the basis of neurosis *is* anxiety.

Now the results advanced by Miller and his group will not allow the setting forth of definite conclusions, nor will Manhold's results allow conclusions which could be held with a great degree of certitude. *However,* the important fact which I believe was missed in the present article is that we now have results of two studies, made at two different times, with two different populations and two different personality tests *both* of which have produced results exhibiting a significant relationship between personality factors and periodontal conditions. Thus, the hypothesis of a relationship between personality and periodontal factors is far more tenable. Therefore, we may now paraphrase, with a certain degree of impunity, Miller's statement and say that we may well *have* a method of evaluating the degree of emotional involvement in periodontal disease, and thus have another valuable instrument for diagnosis and treatment of periodontal disease. A statement of this nature is admittedly still open to controversy. *But,* with Manhold's earlier results now corroborated by those of Miller's group, a working hypothesis certainly appears tenable.

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